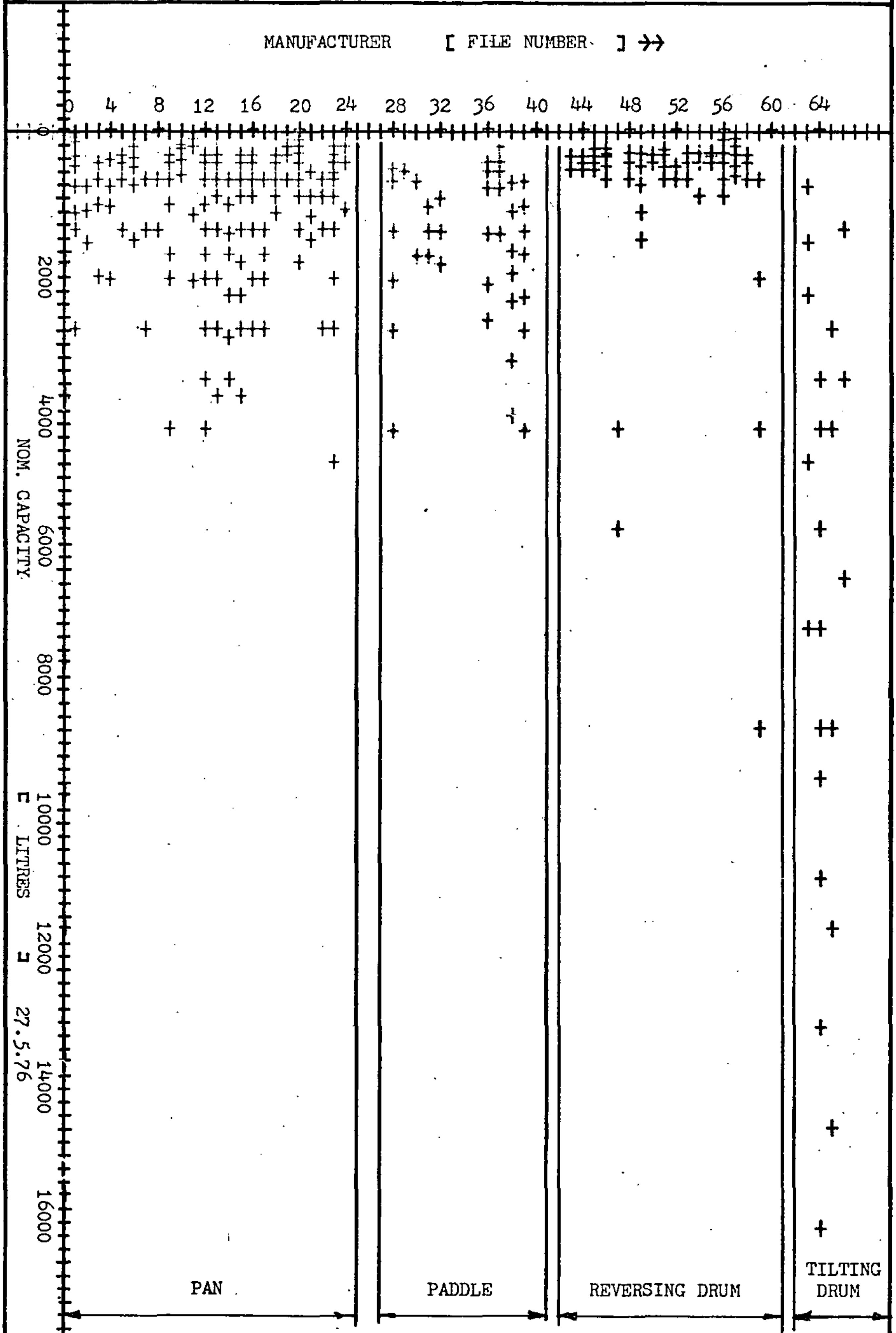
APPENDIX

A

GRAPHS

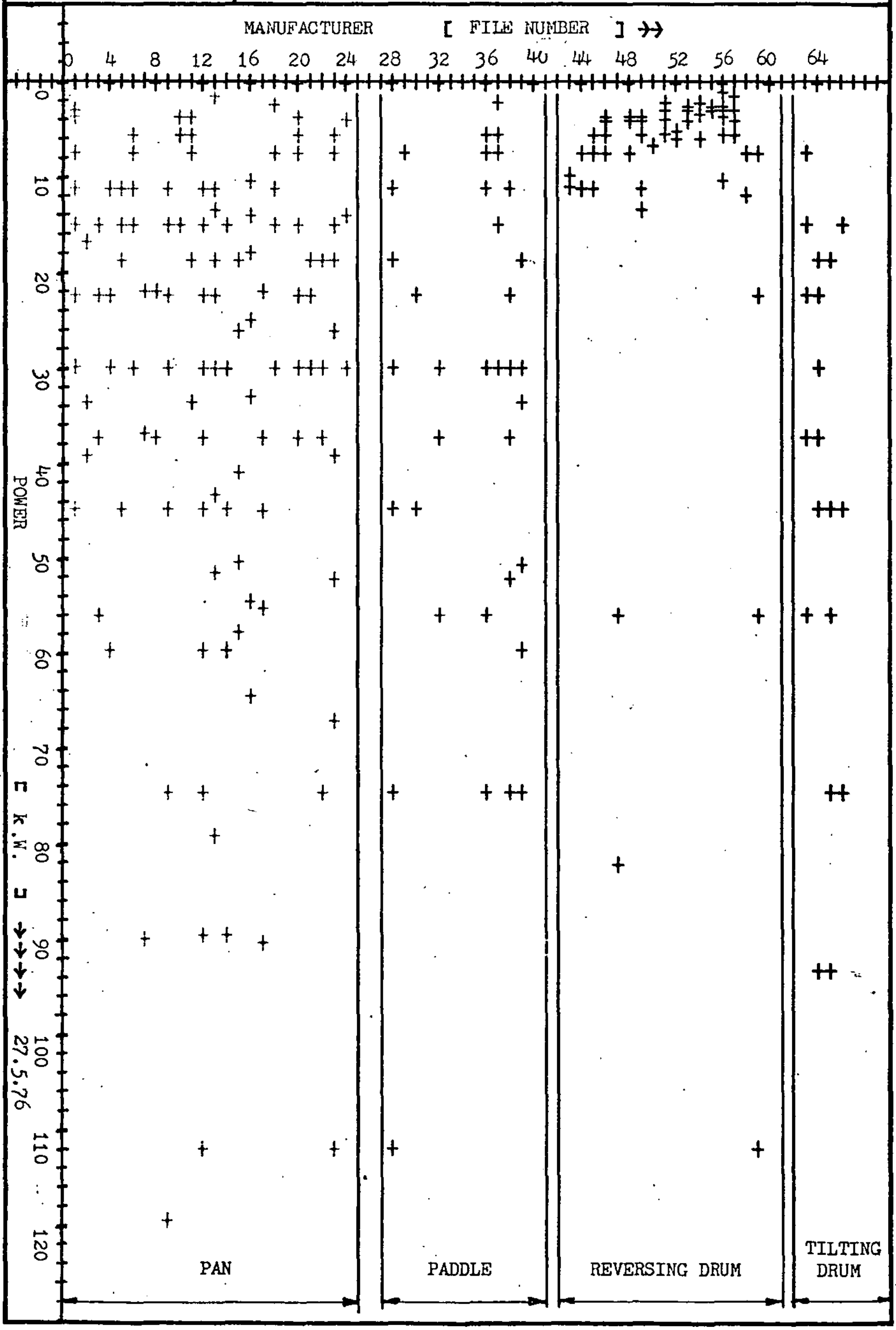
Plot 3.1

MANUFACTURER AGAINST NOM CAPACITY



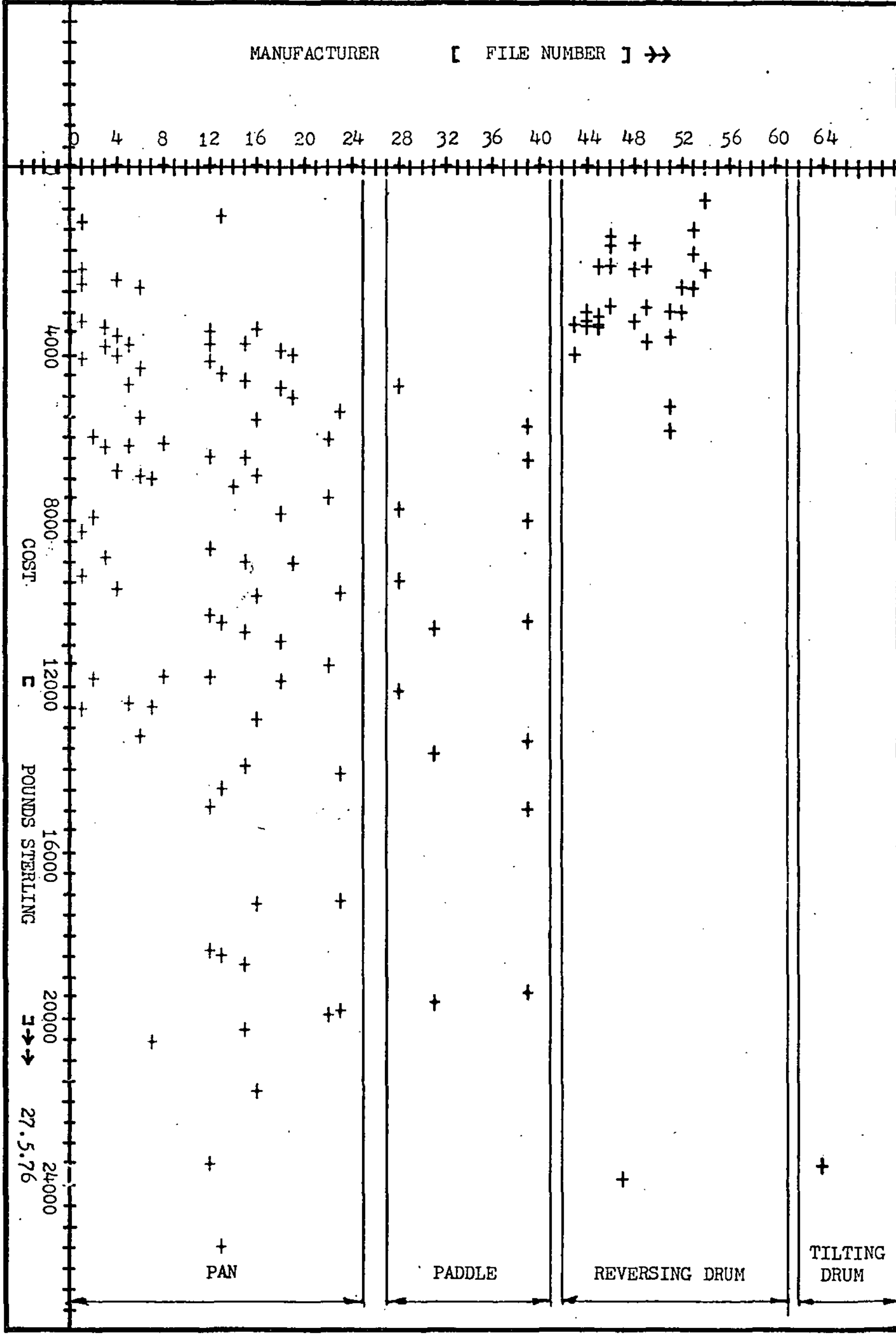
MANUFATURER AGAINST POWER

Plot 3.2



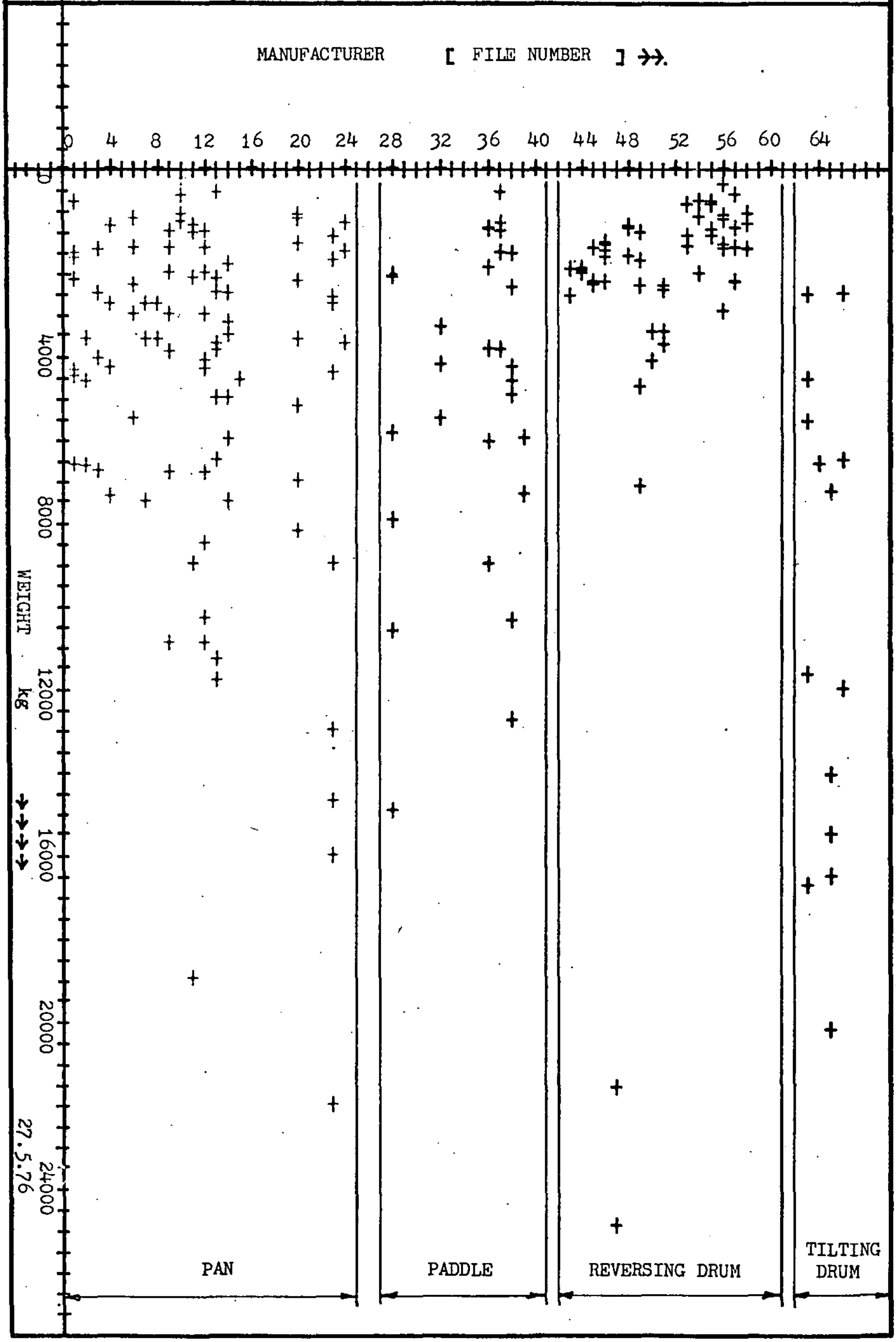
MANUFACTURER AGAINST COST

Plot 3.3



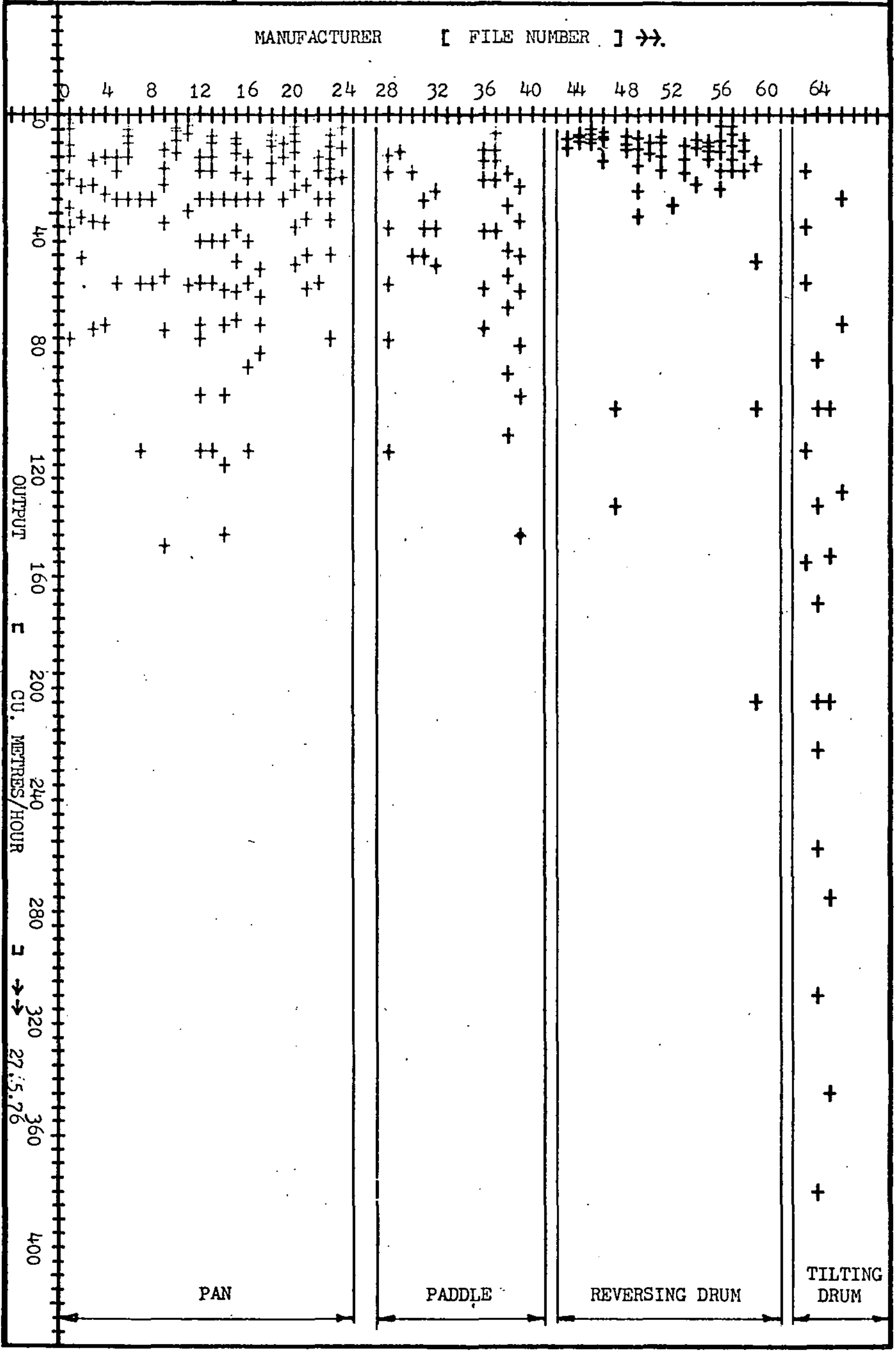
Plot 3.4

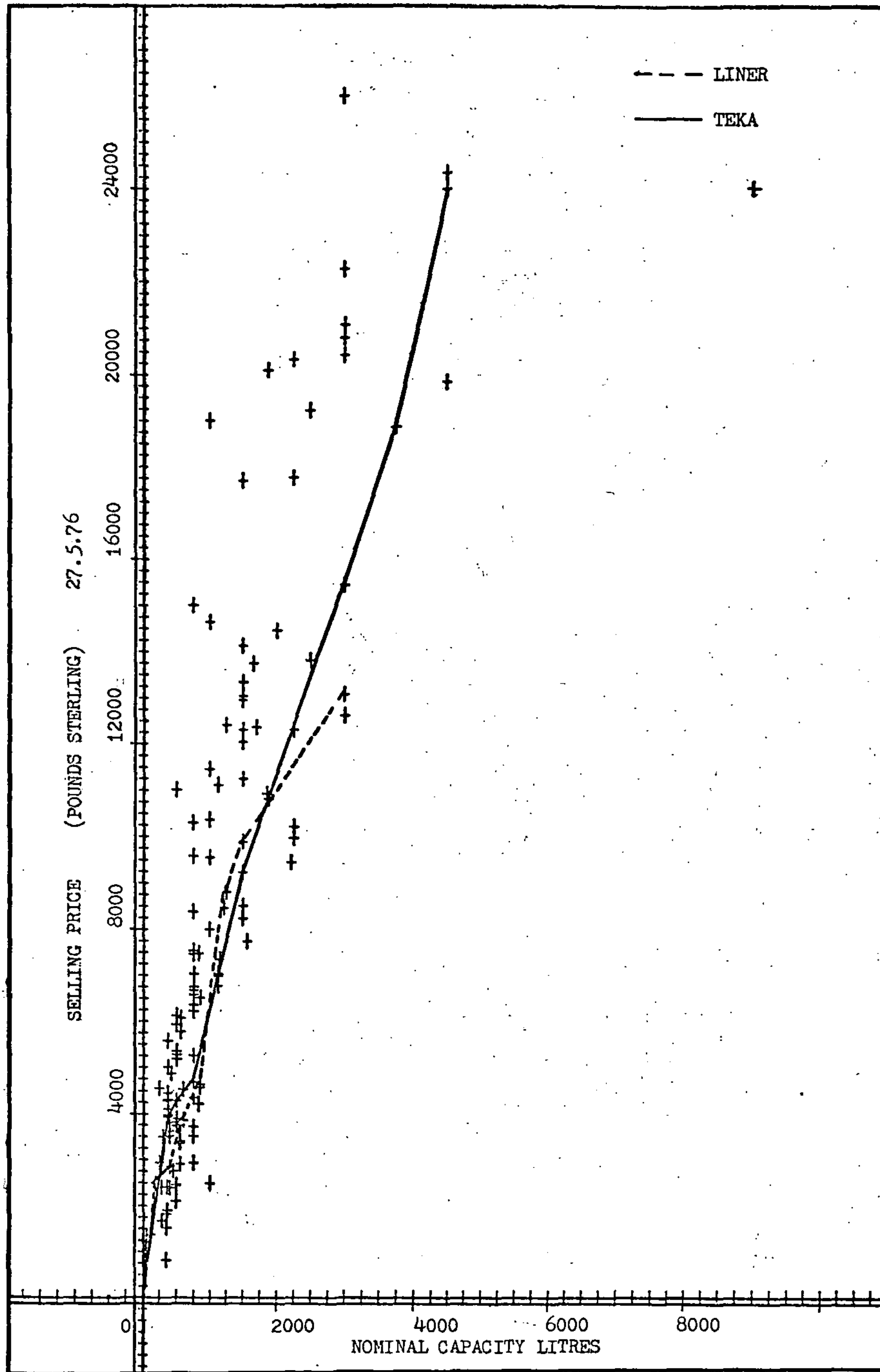
MANUFACTURER AGAINST WEIGHT



Plot 3.5

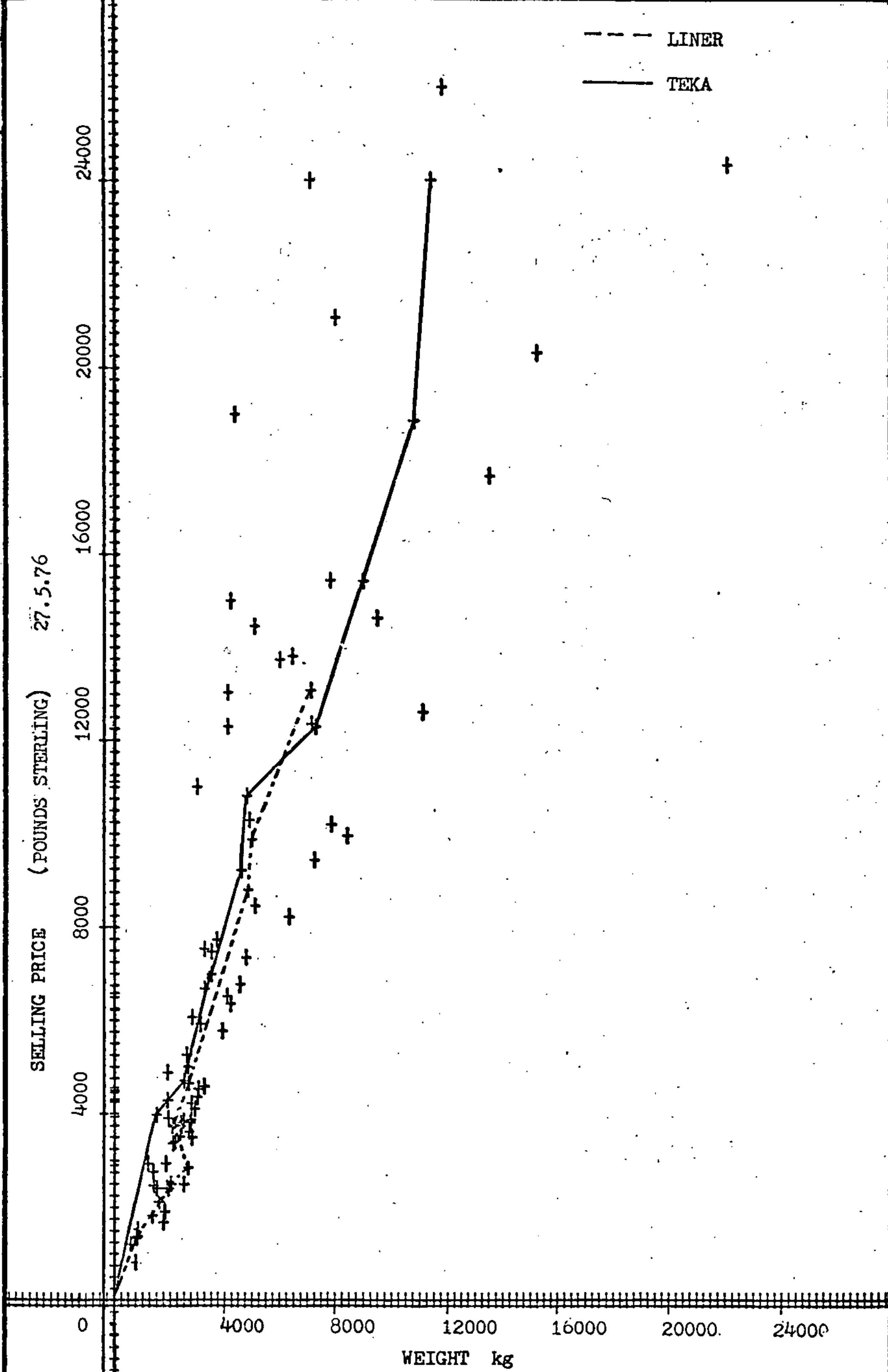
MANUFACTURER AGAINST OUTPUT





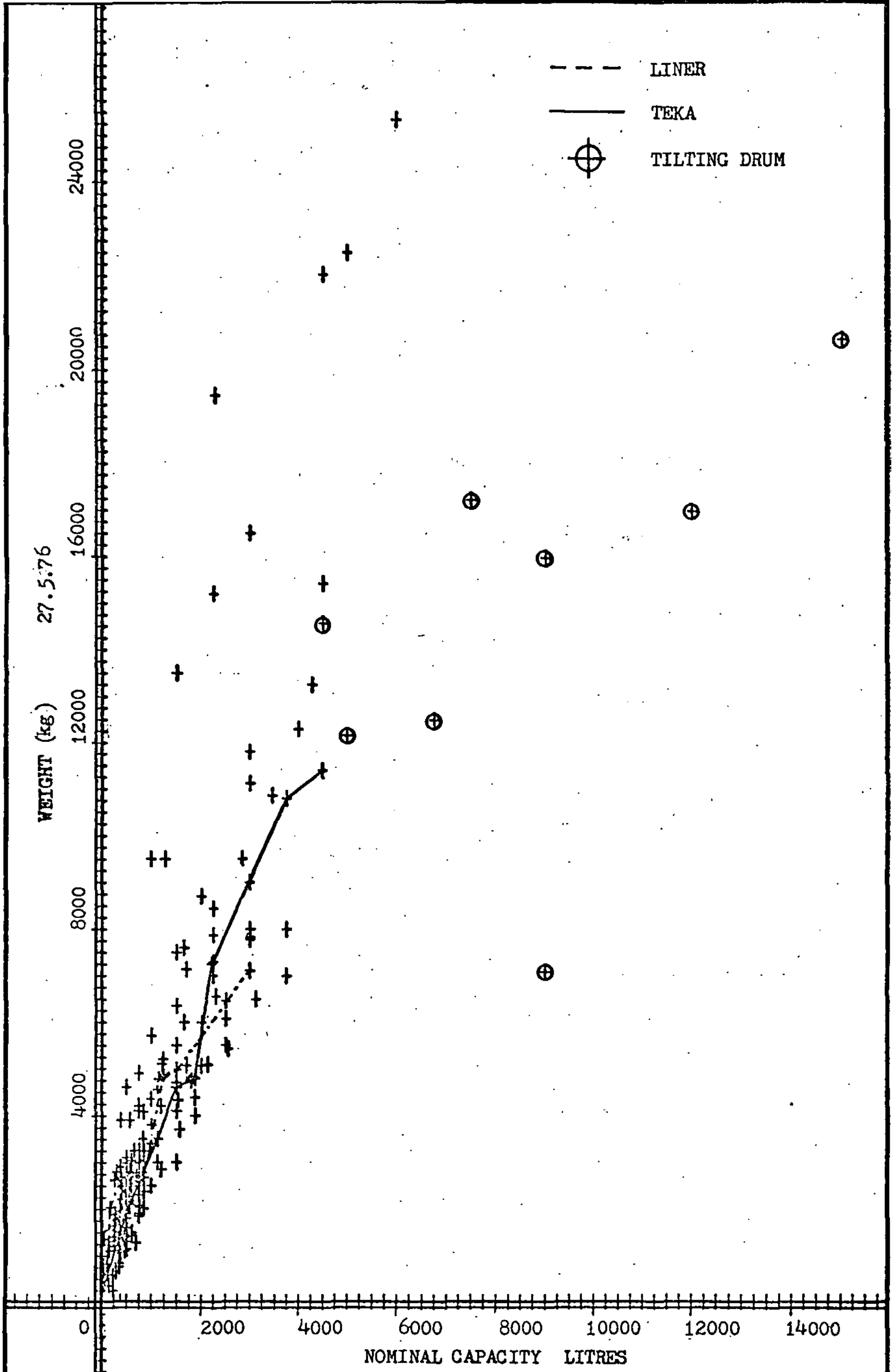
SELLING PRICE AGAINST NOMINAL CAPACITY

Plot 3.6



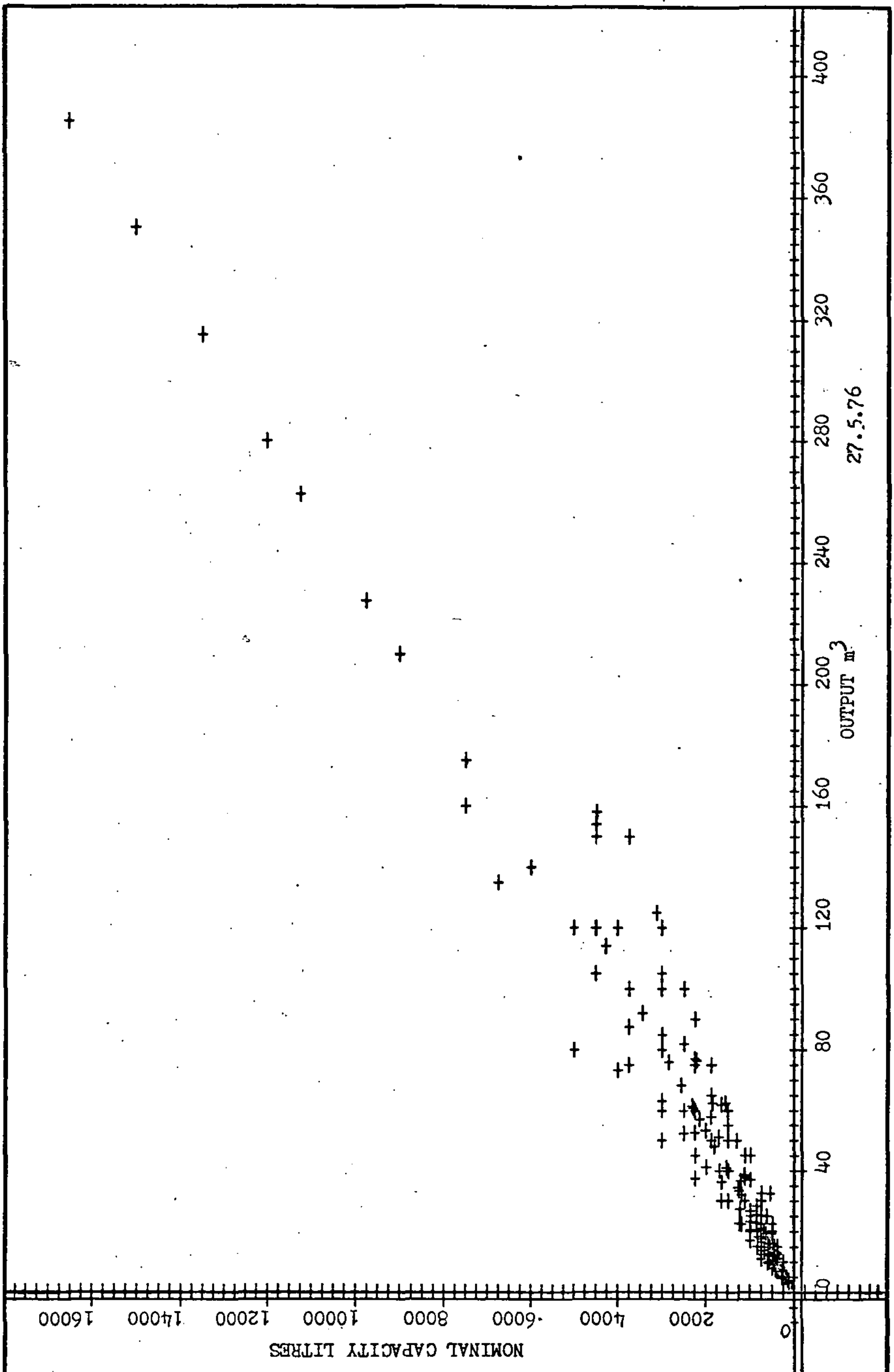
SELLING PRICE AGAINST WEIGHT

Plot 3.7



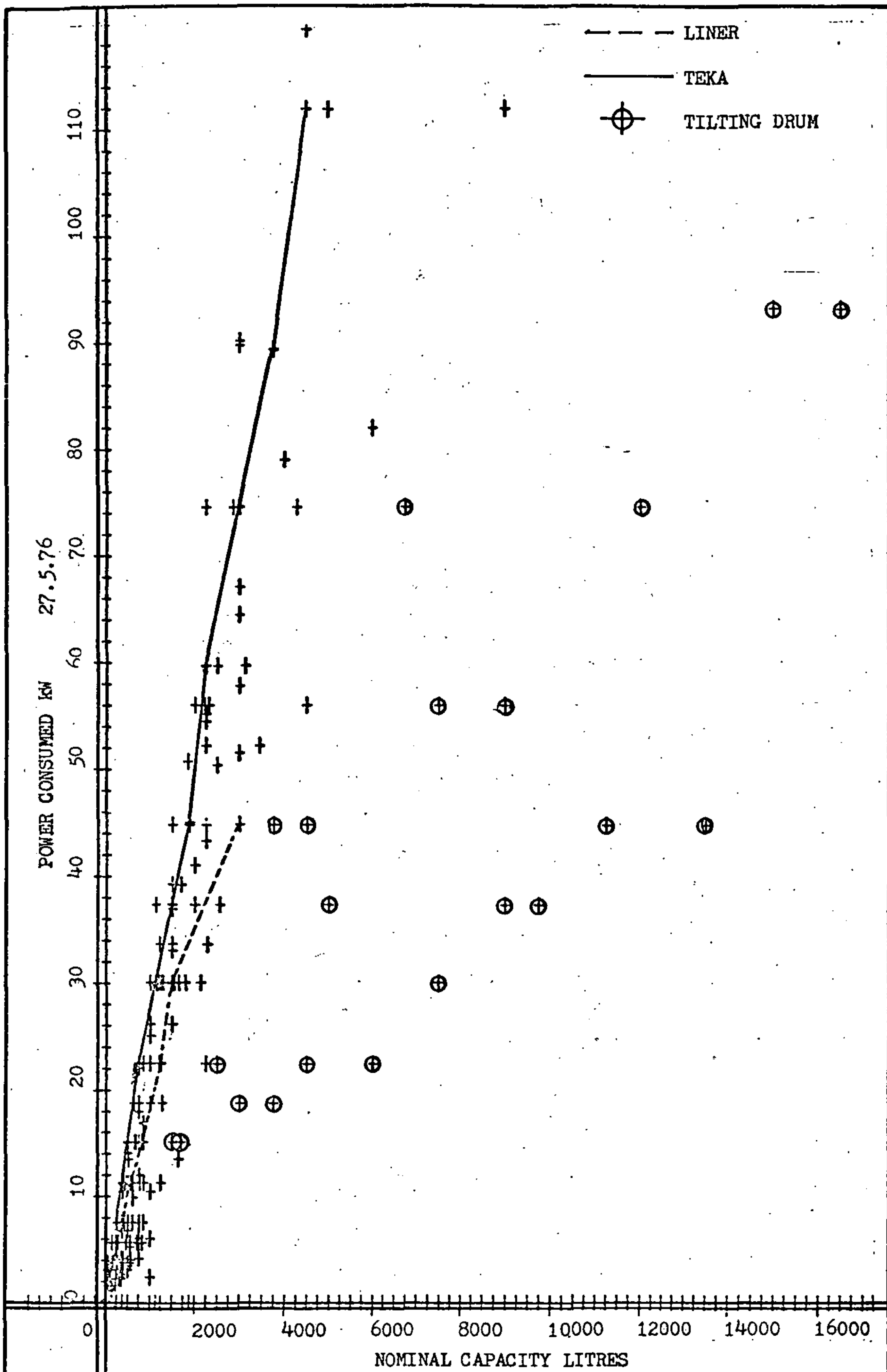
WEIGHT AGAINST NOMINAL CAPACITY

Plot 3.8



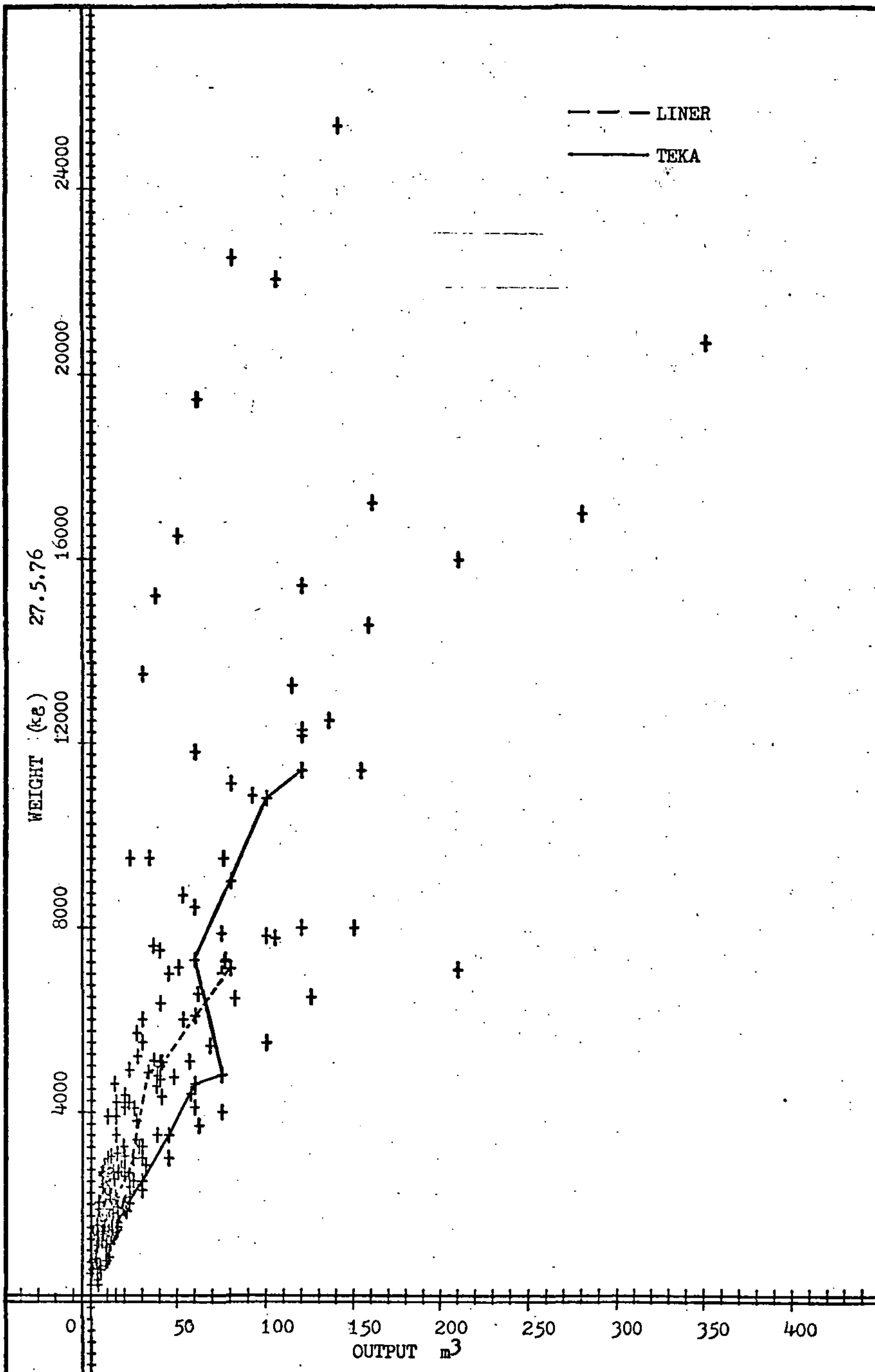
NOMINAL CAPACITY AGAINST OUTPUT

Plot 3.9



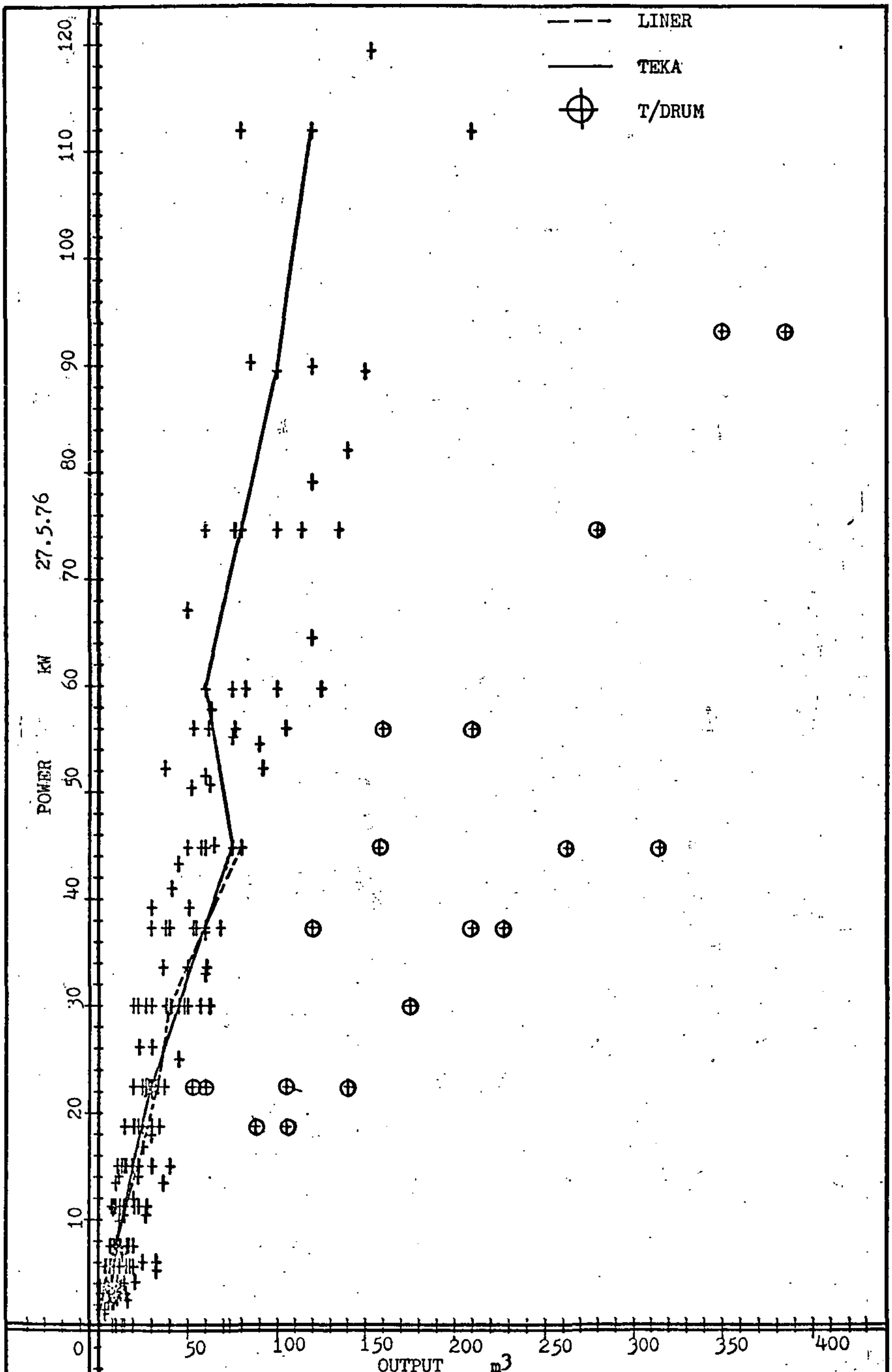
POWER AGAINST NOMINAL CAPACITY

Plot 3.10



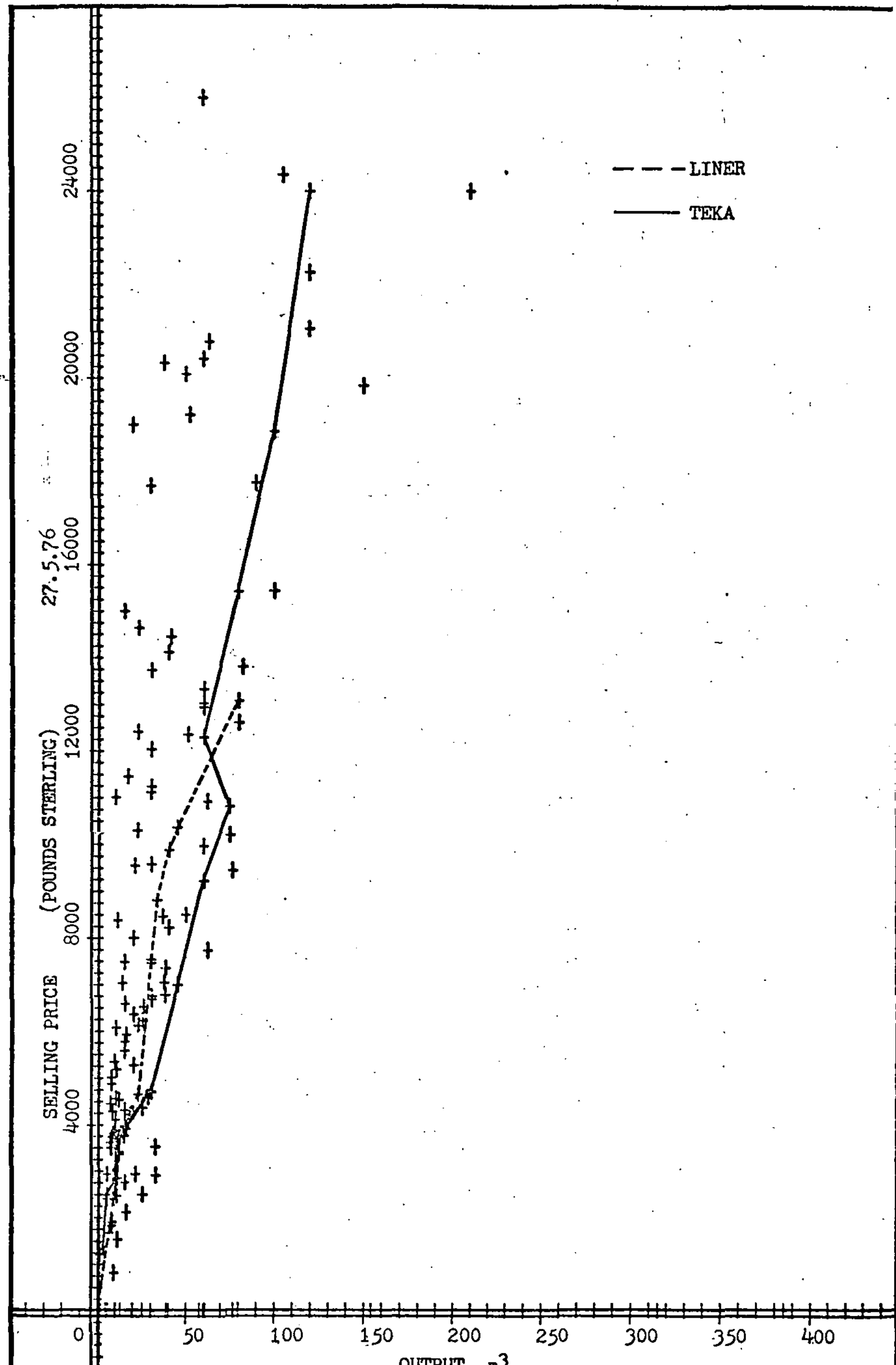
WEIGHT AGAINST OUTPUT

Plot 3.11



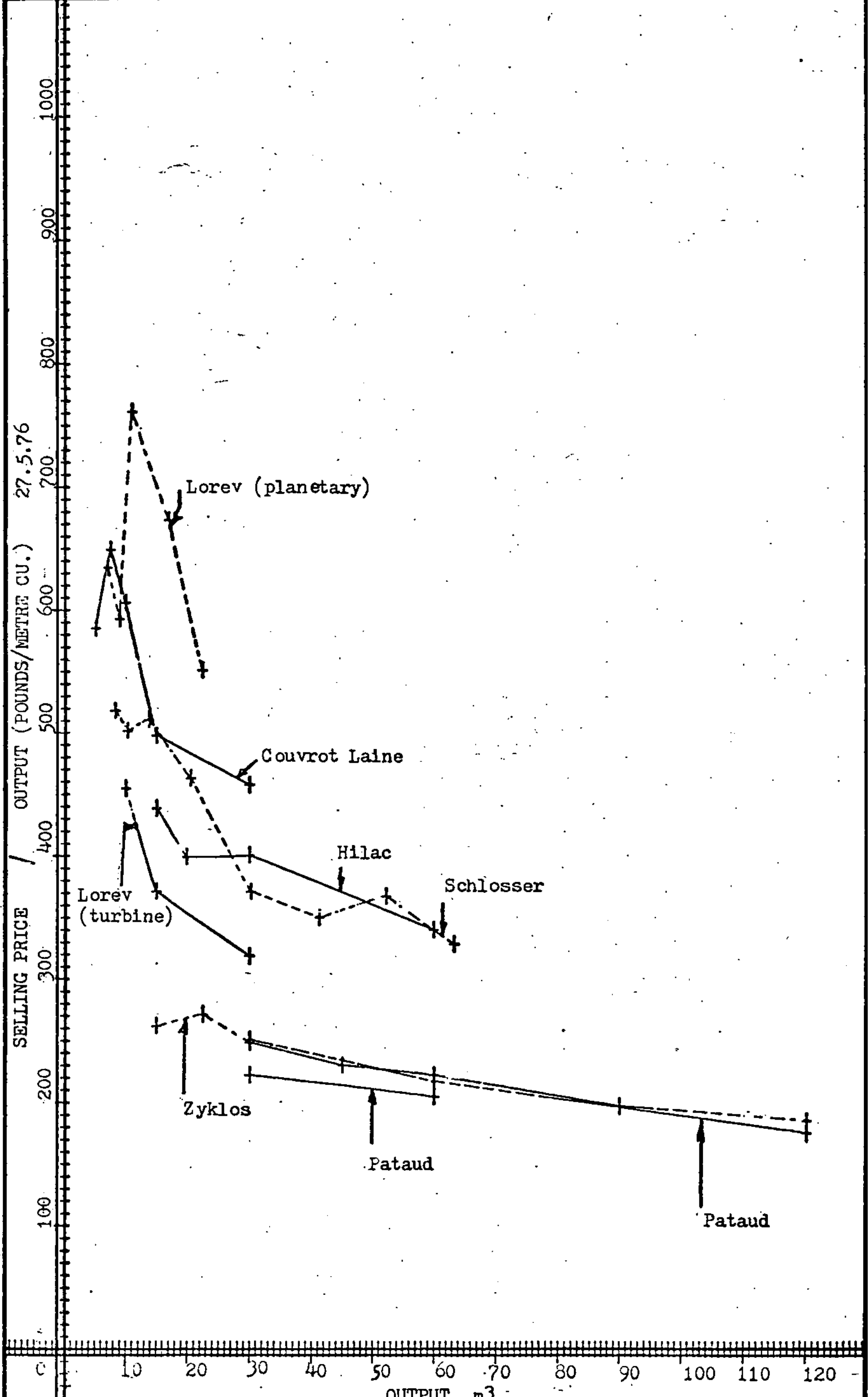
POWER AGAINST OUTPUT

Plot 3.12



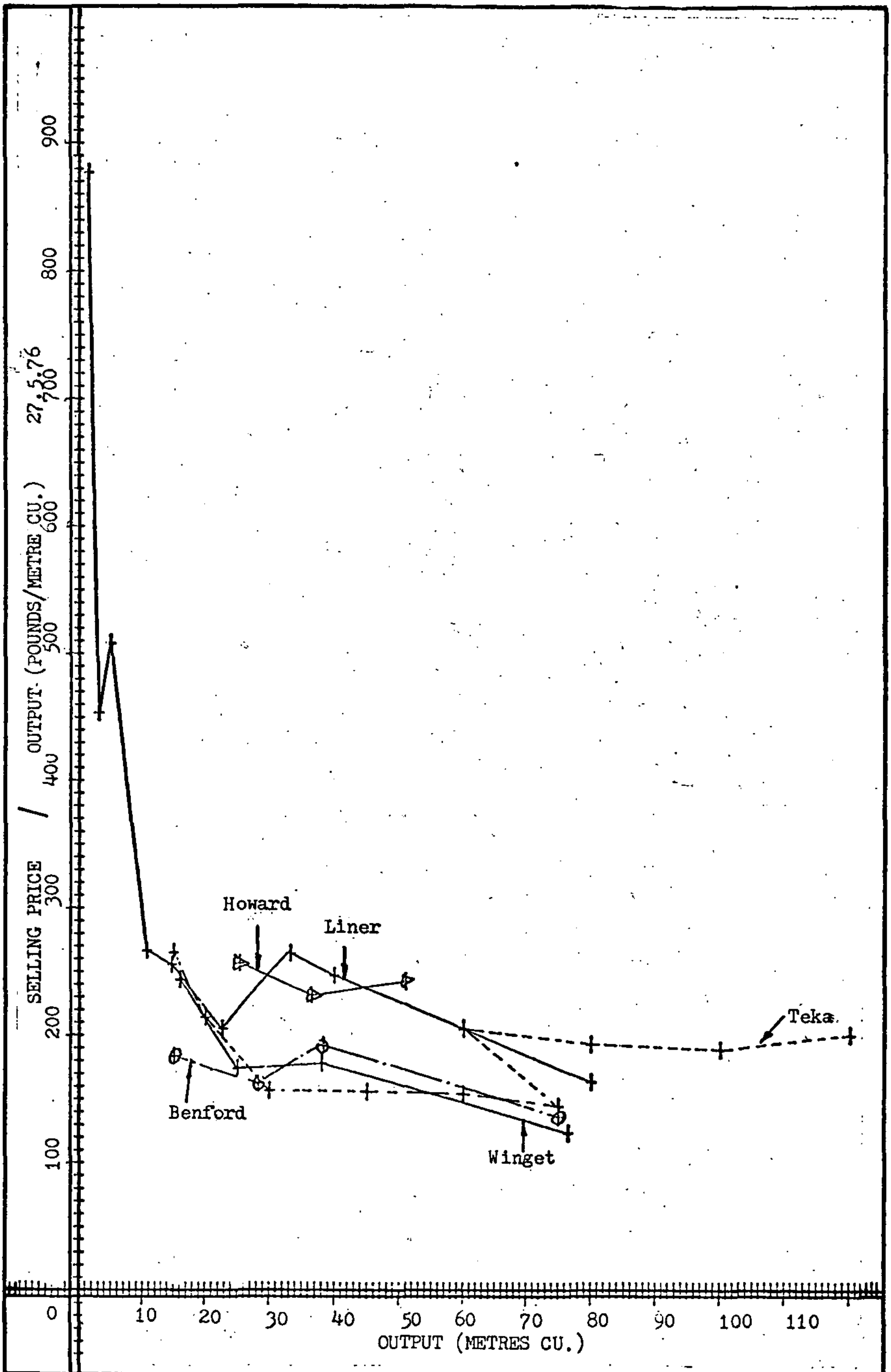
SELLING PRICE AGAINST OUTPUT

Plot 3.13



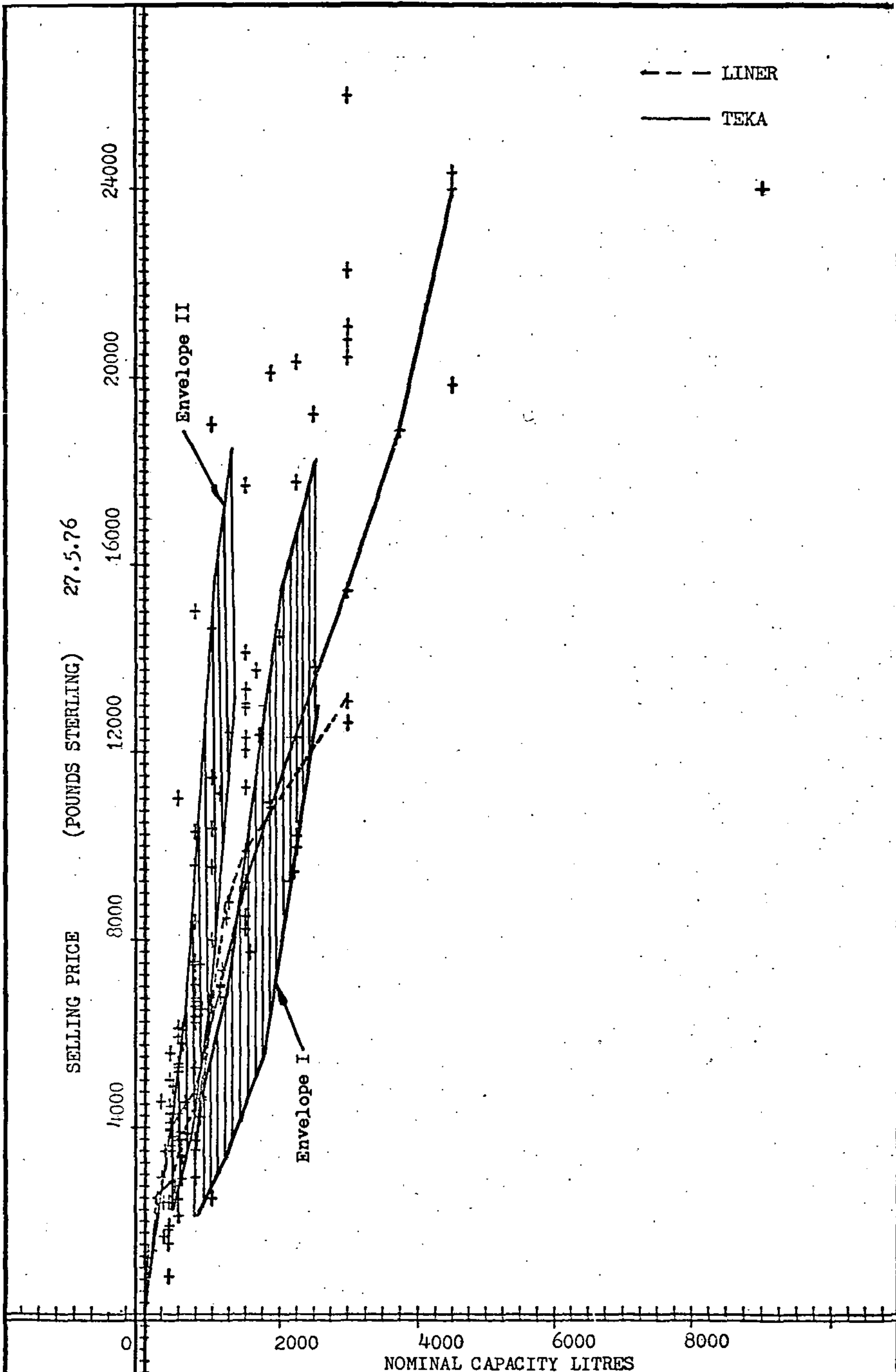
SELLING PRICE AGAINST OUTPUT

Plot 3.14



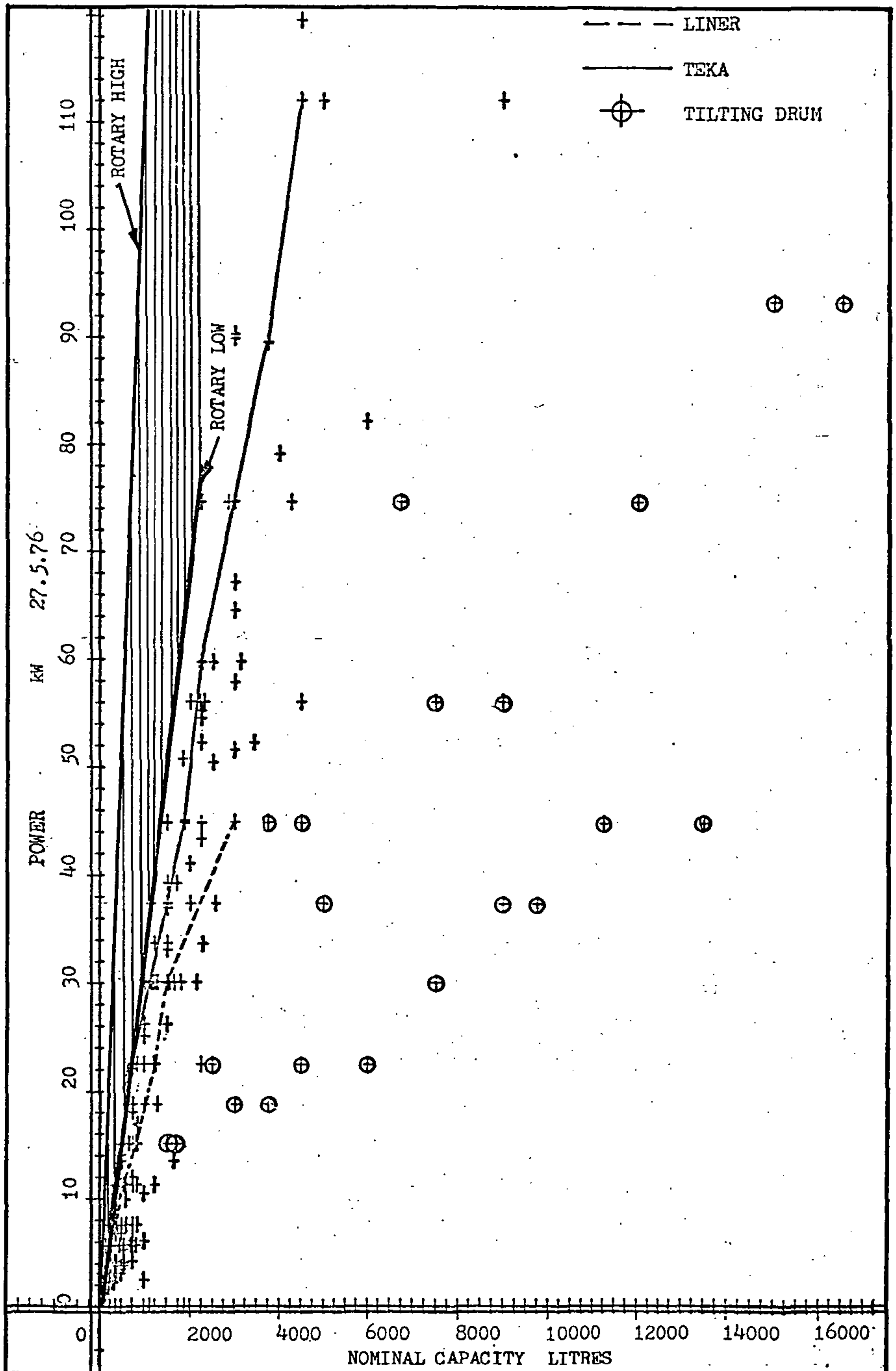
SELLING PRICE AGAINST OUTPUT

Plot 3.15



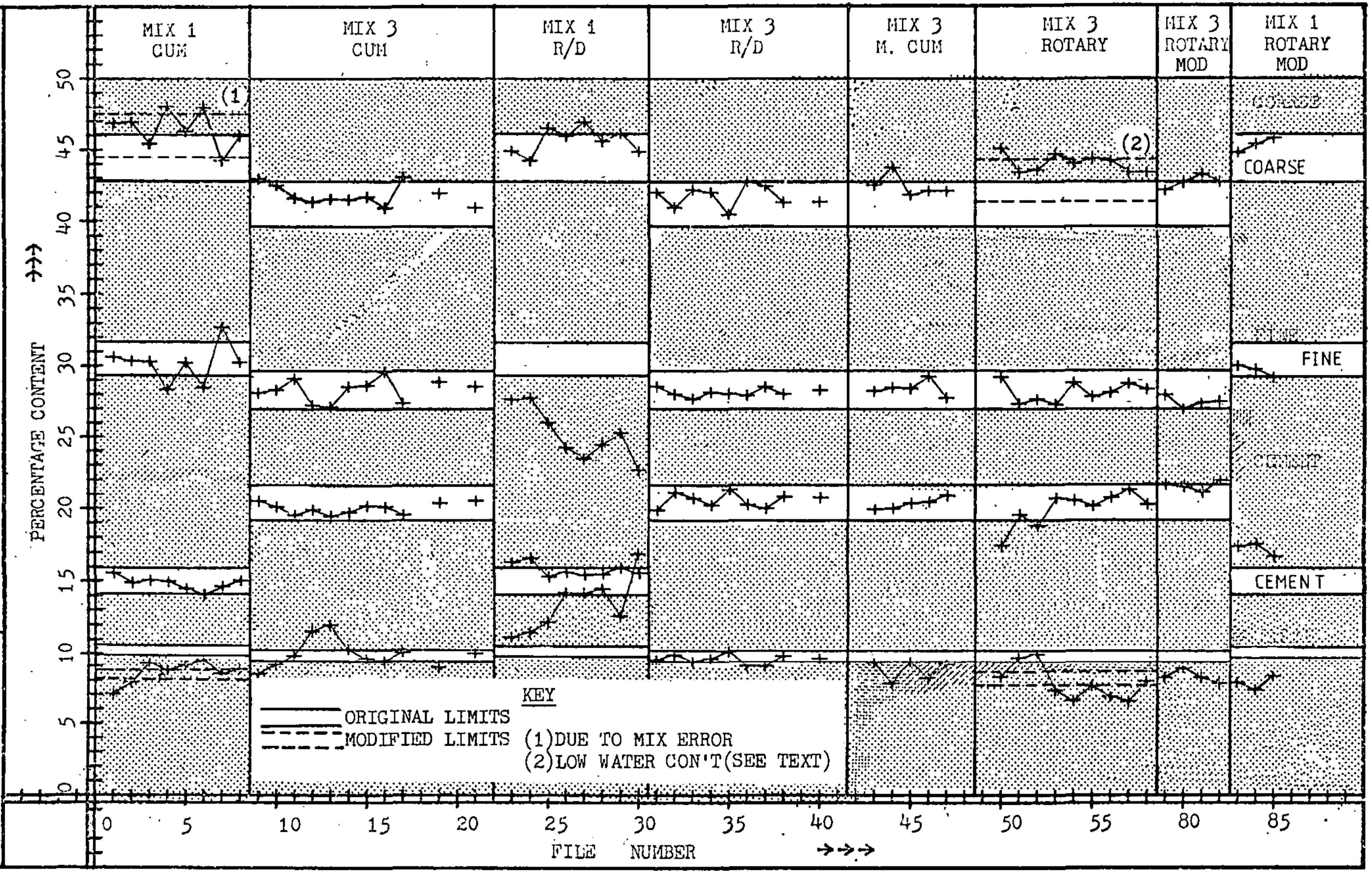
SELLING PRICE AGAINST NOMINAL CAPACITY

Plot 4.1



POWER AGAINST NOMINAL CAPACITY

Plot 4.2

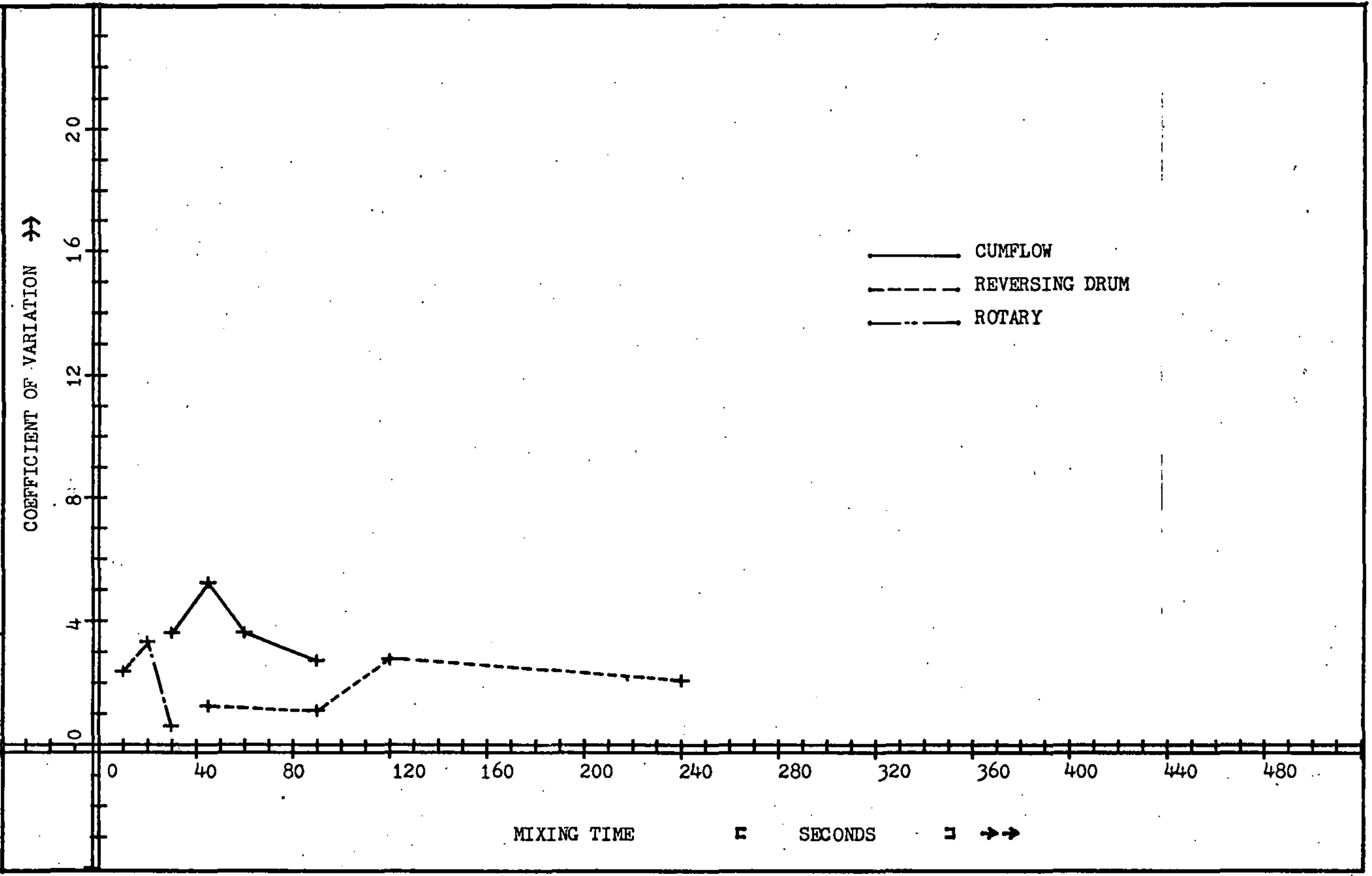


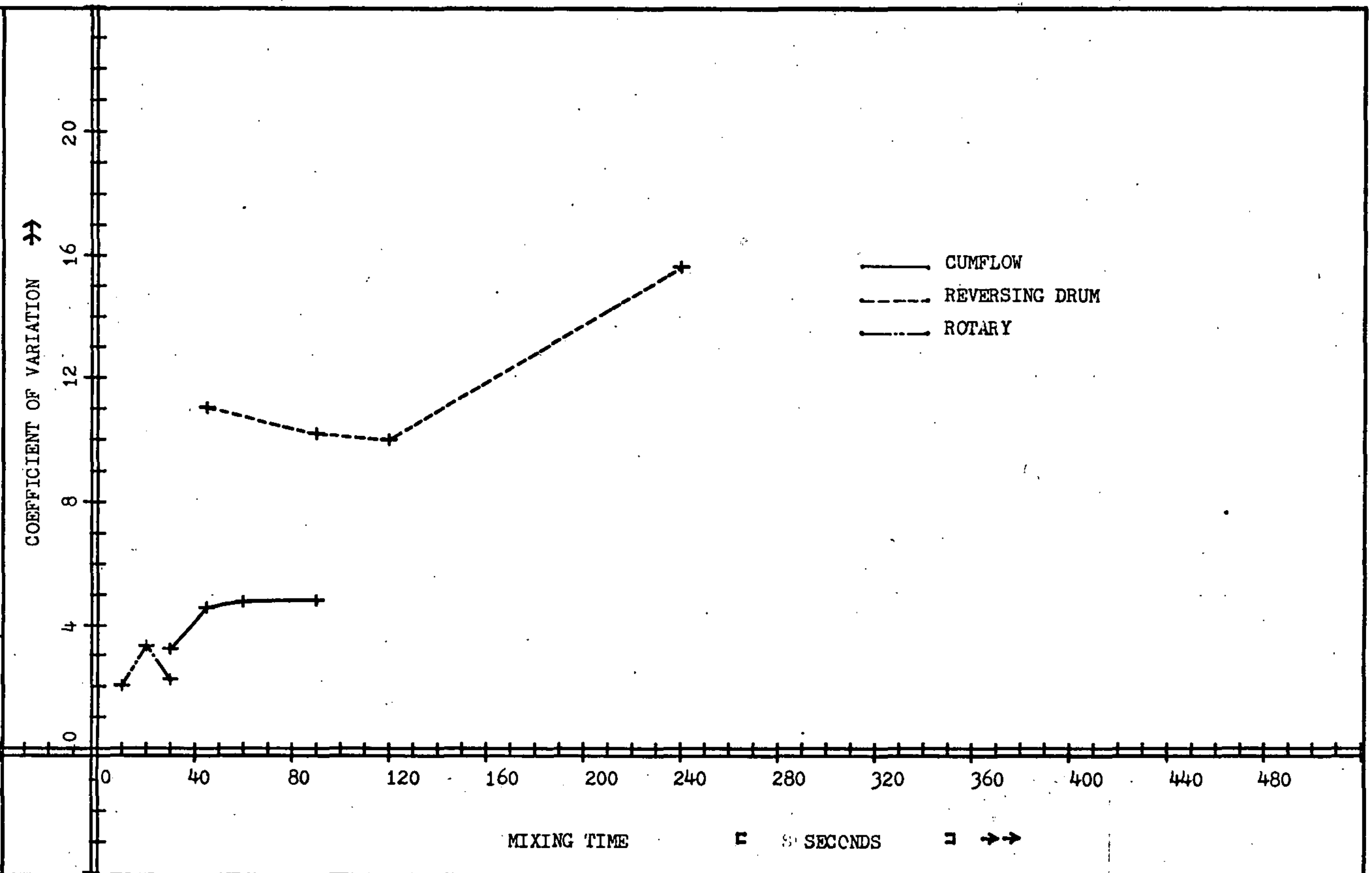
PERCENTAGE CONTENT AGAINST FILE NUMBER

PLOT 7.1

MIX 1 COARSE AGG CON T LINER TESTS.

PLOT 7.2



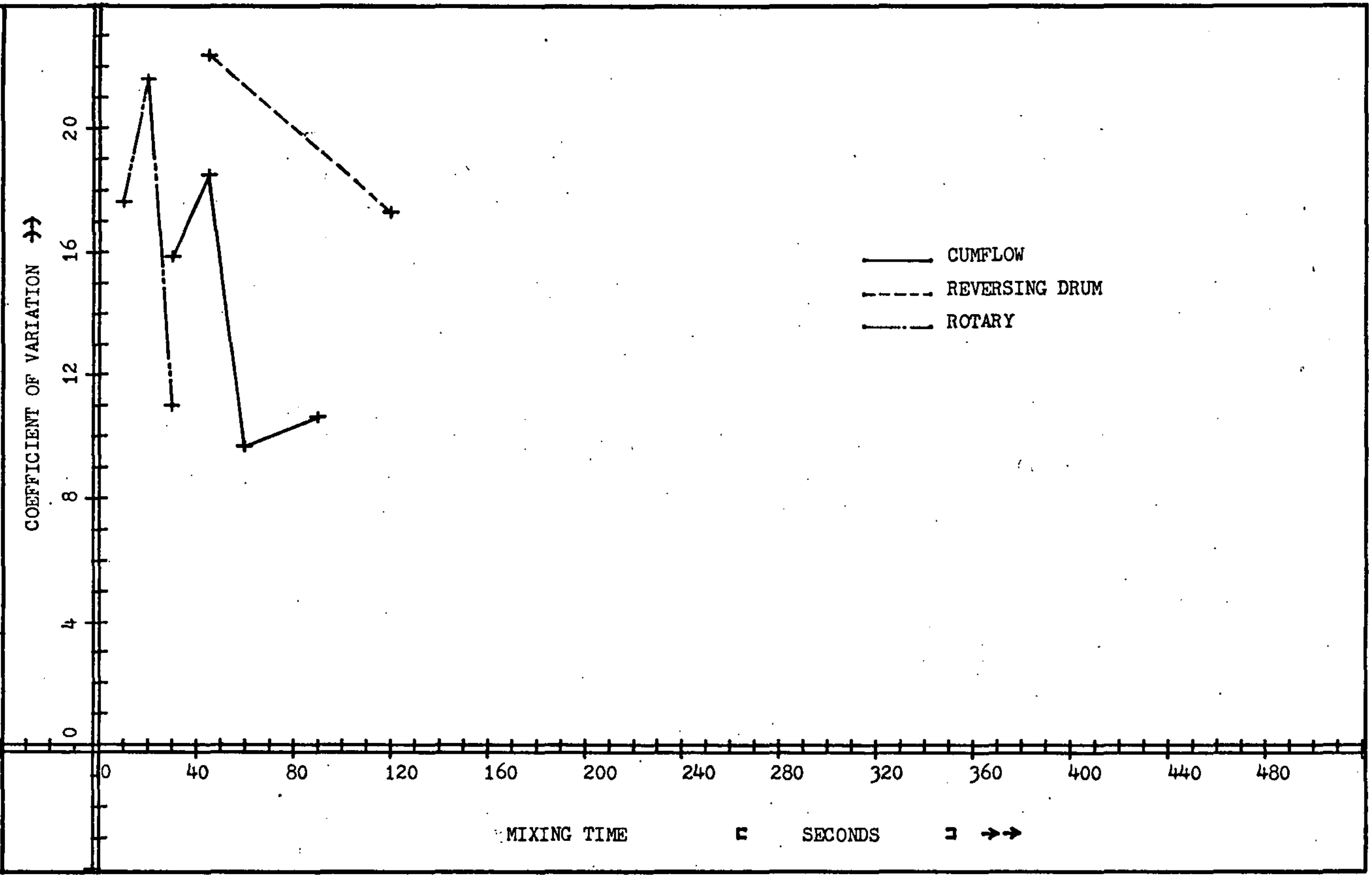


MIX 1 FINES CON T LINER TESTS

PLOT 7.3

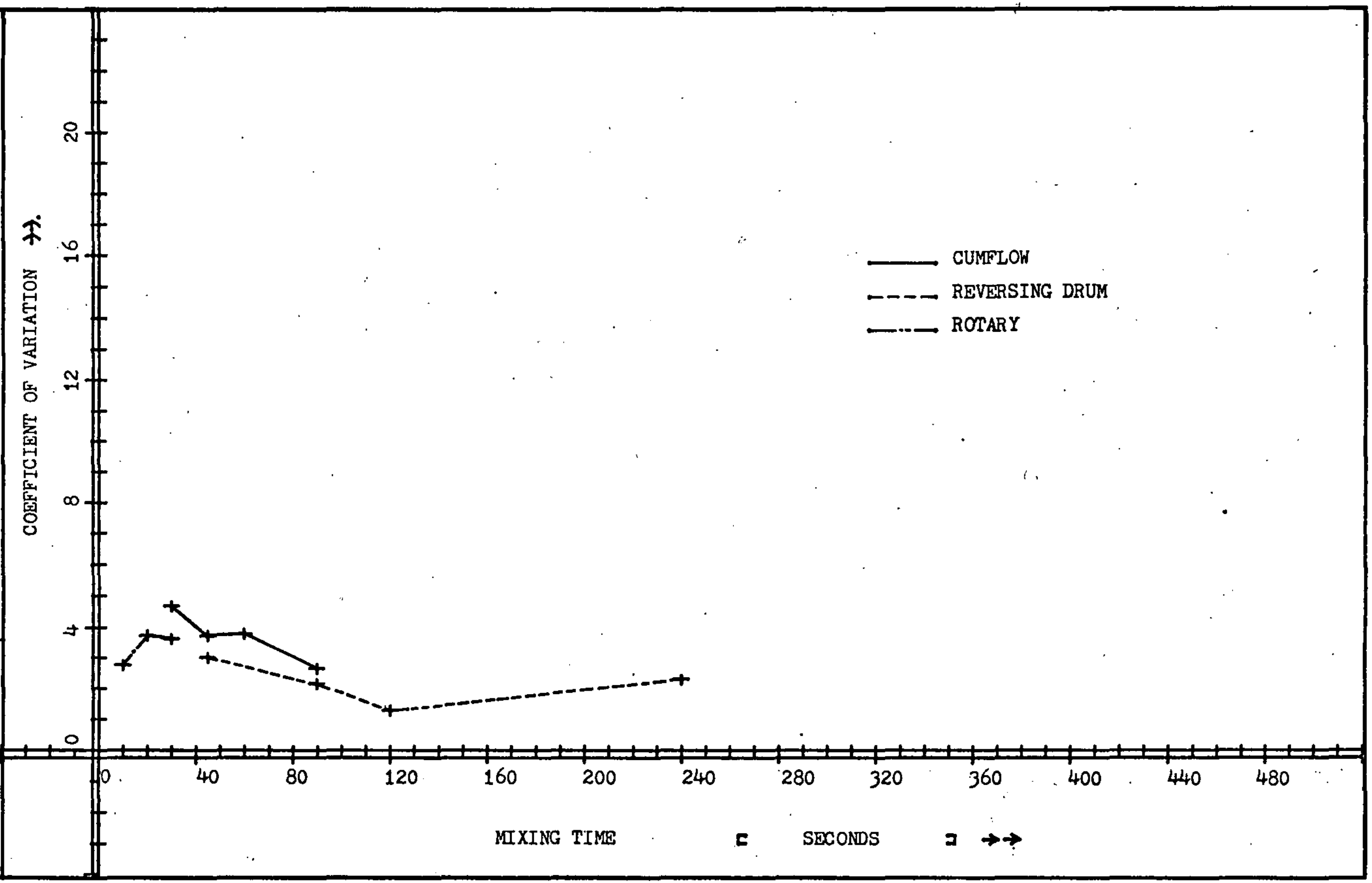
MIX 1 WATER CON T LINER TESTS

PLOT 7.4



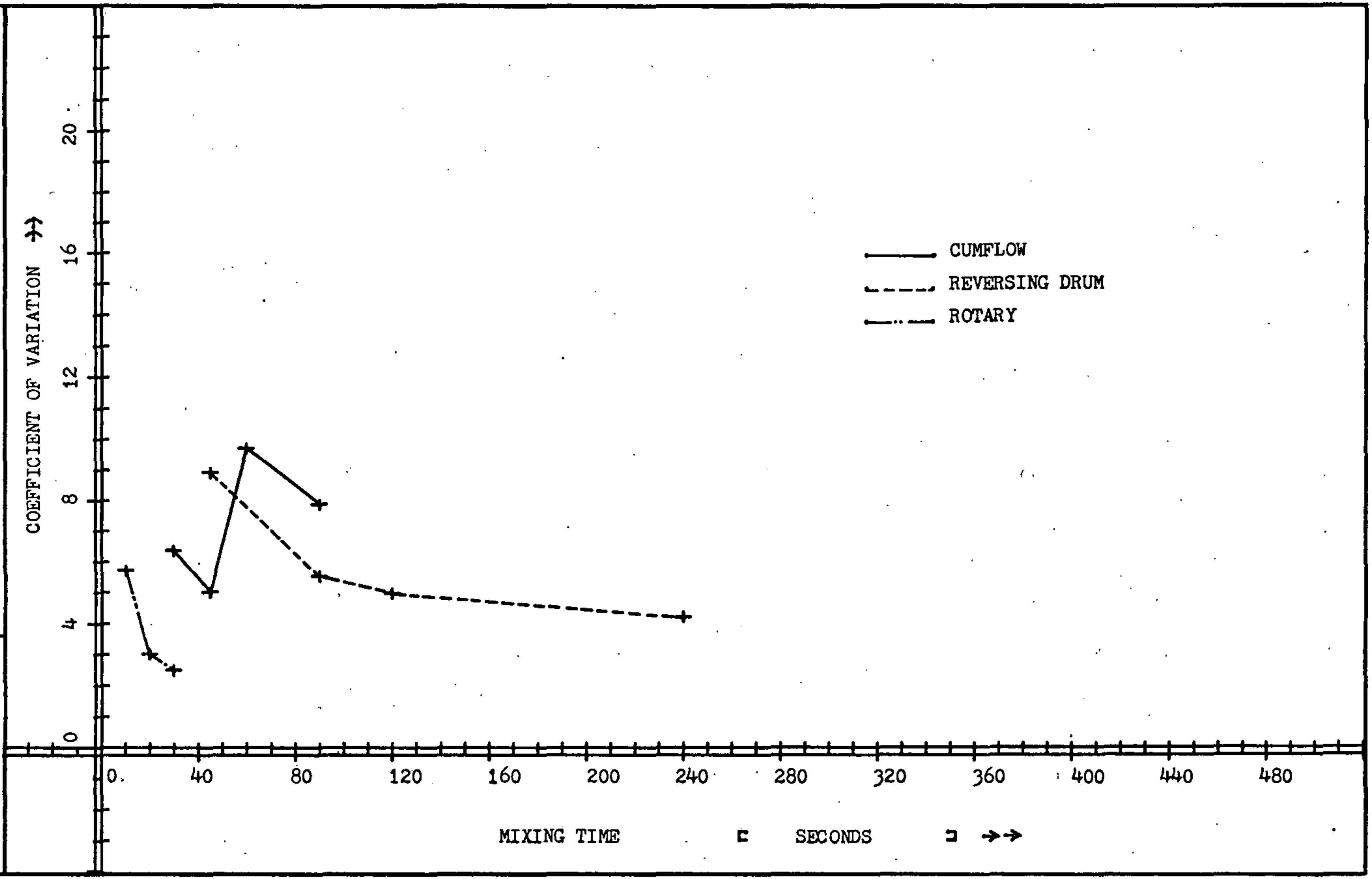
MIX 1 CEMENT CON T LINER TESTS.

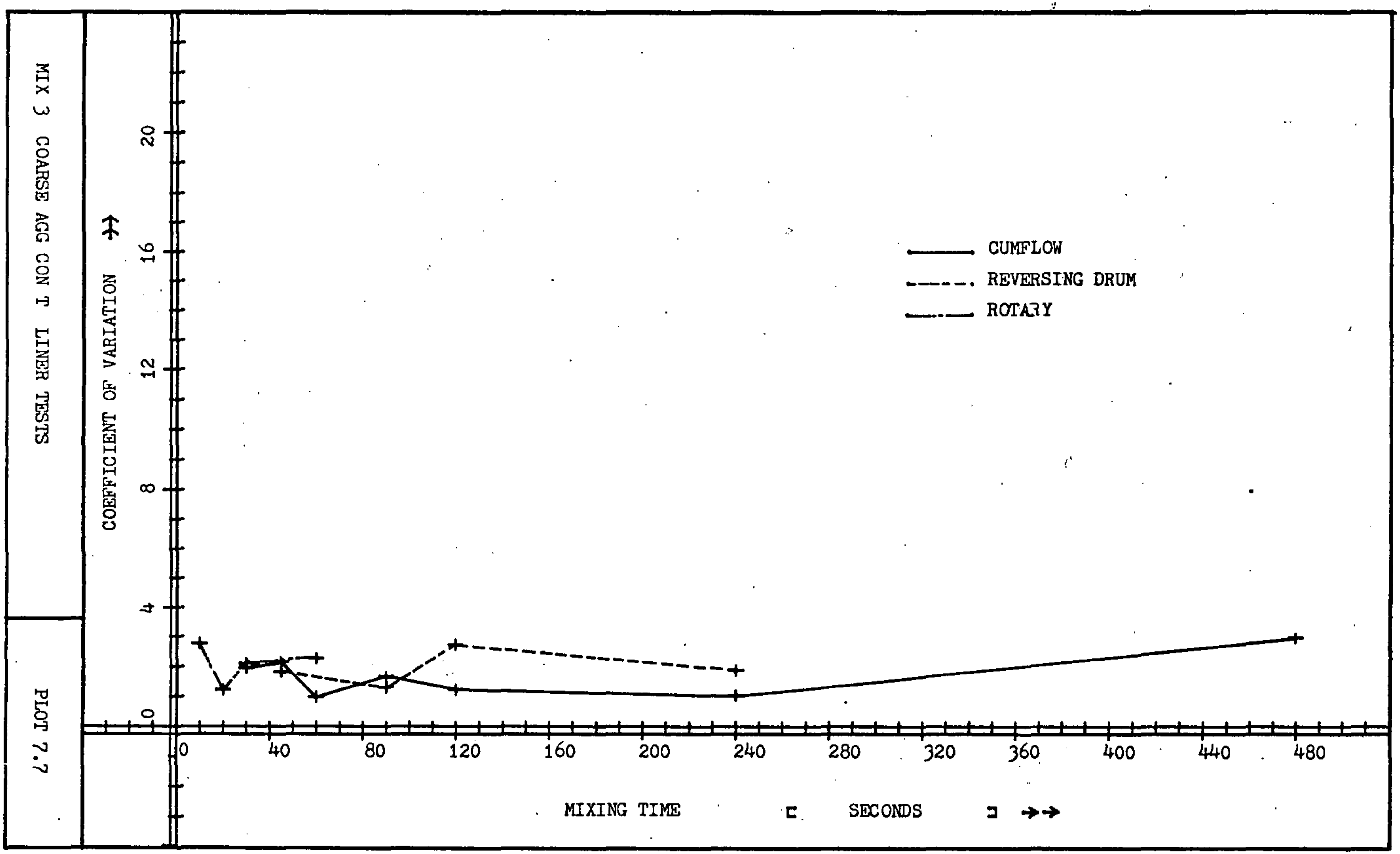
PLOT 7.5

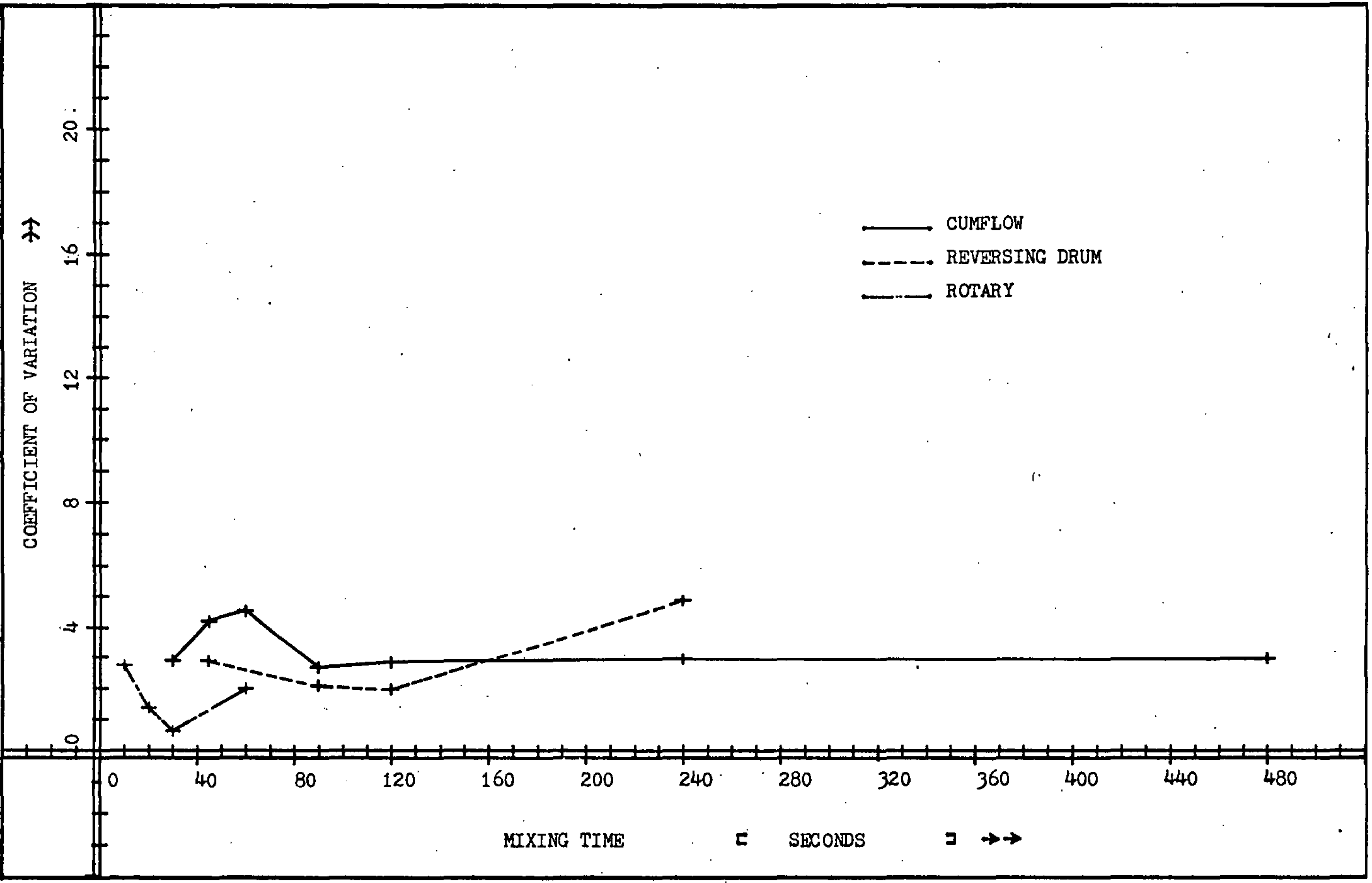


MIX 1 COM P ST LINER TESTS.

PLOT 7.6

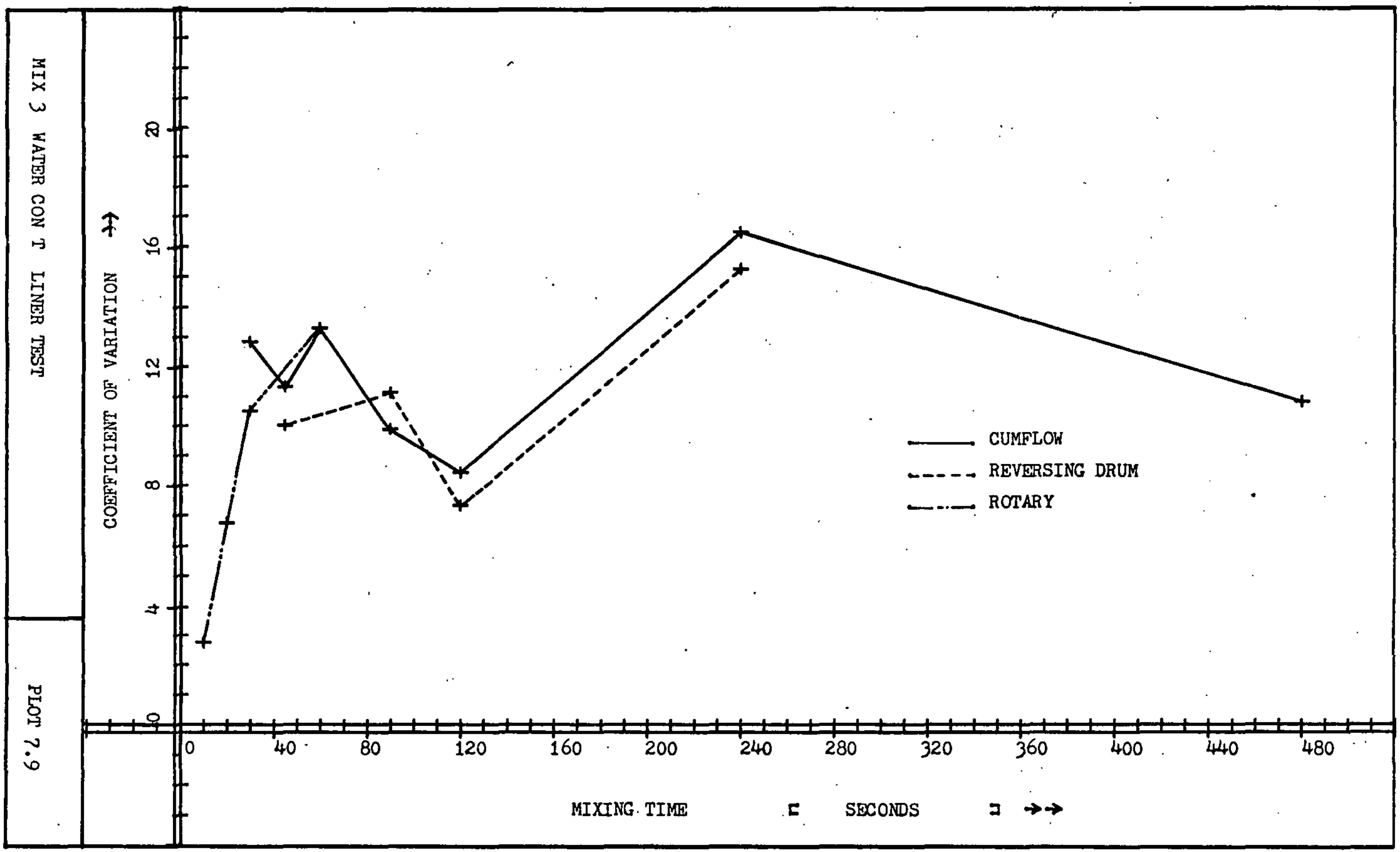


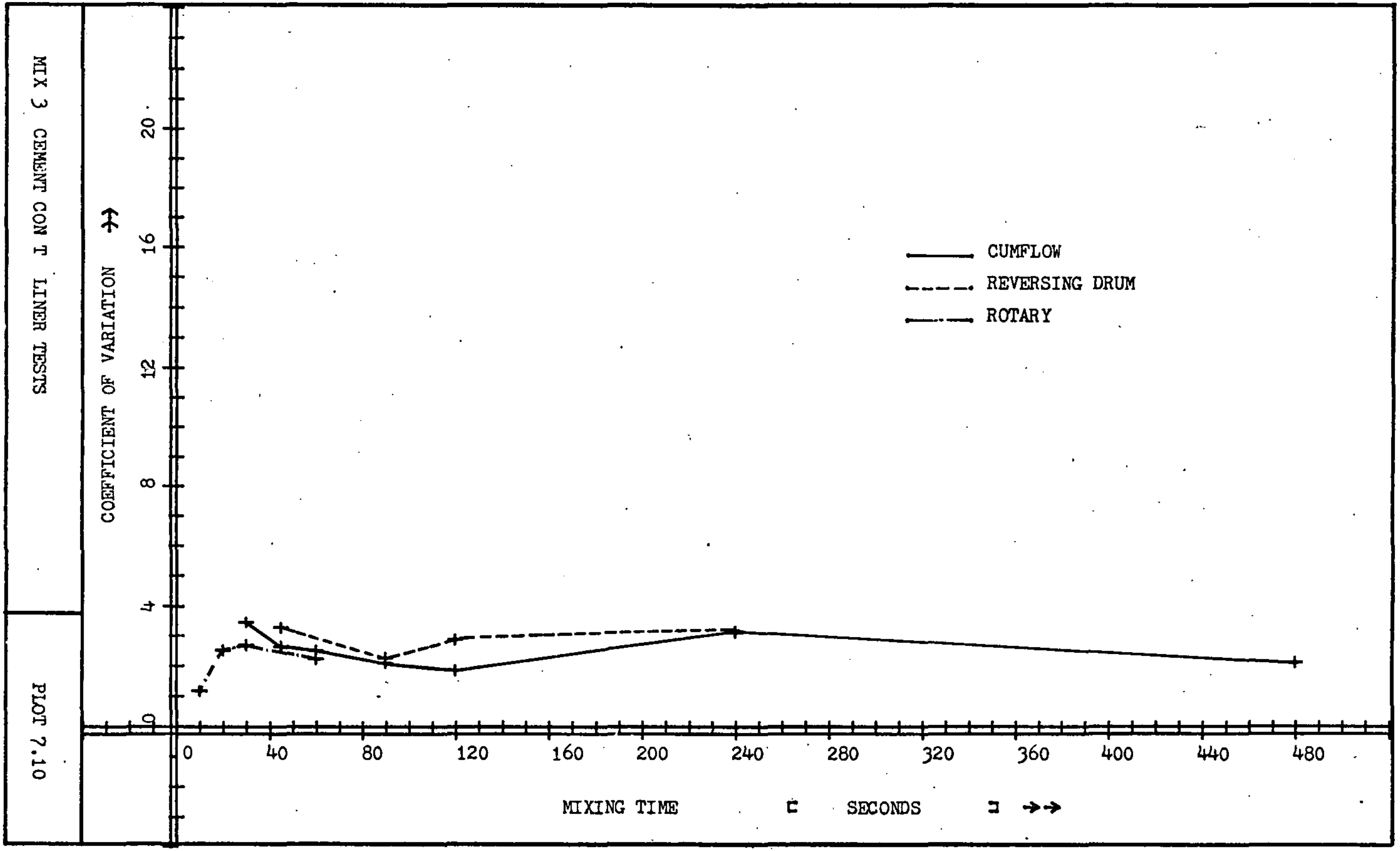

MIX 3 COARSE AGG CON T LINER TESTS
PLOT 7.7
COEFFICIENT OF VARIATION →
0
4
8
12
16
20
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME [SECONDS] →
CUMFLOW
REVERSING DRUM
ROTARY

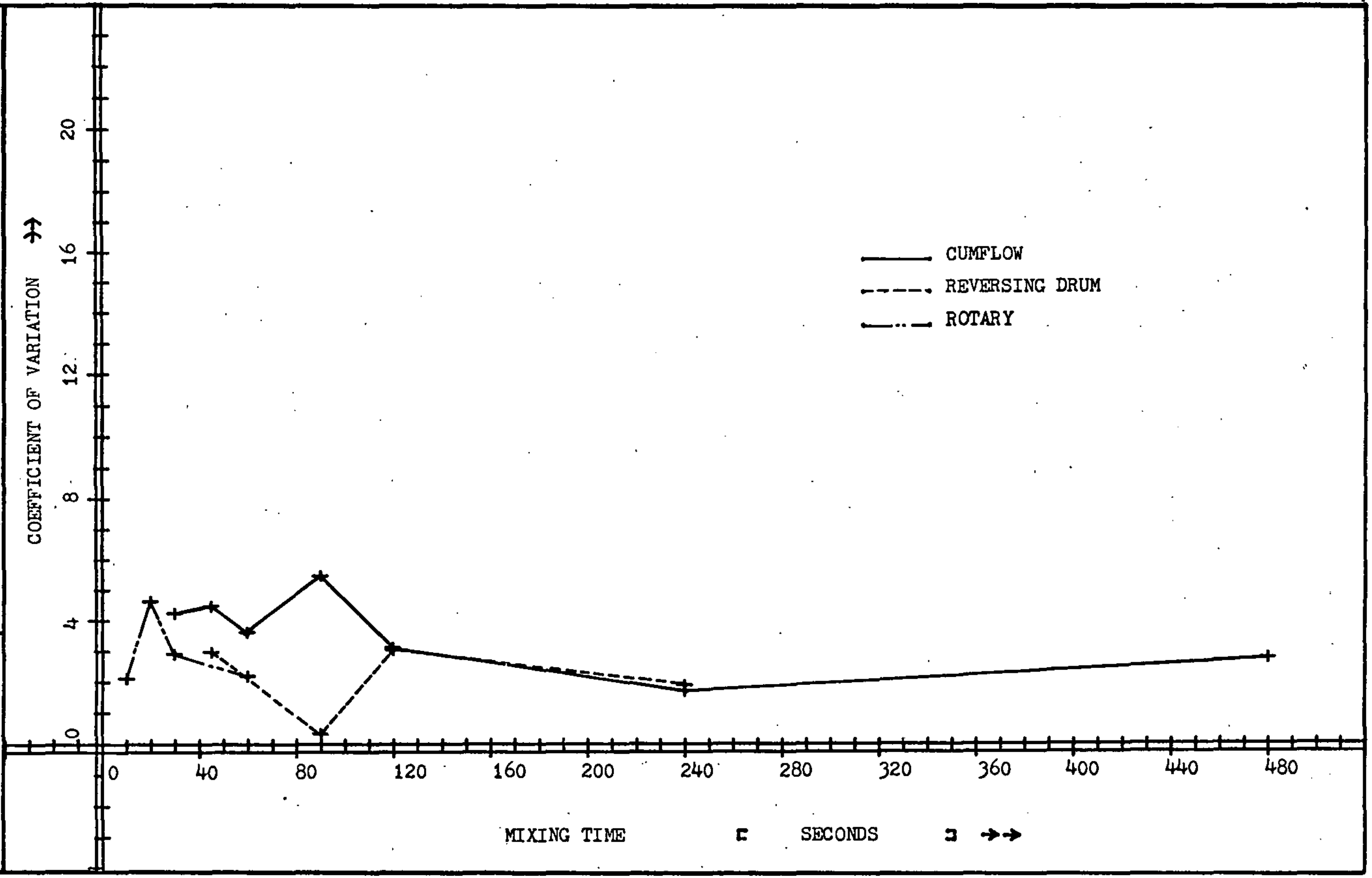


MIX 3 FINES CON T LINER TESTS

PLOT 7.8

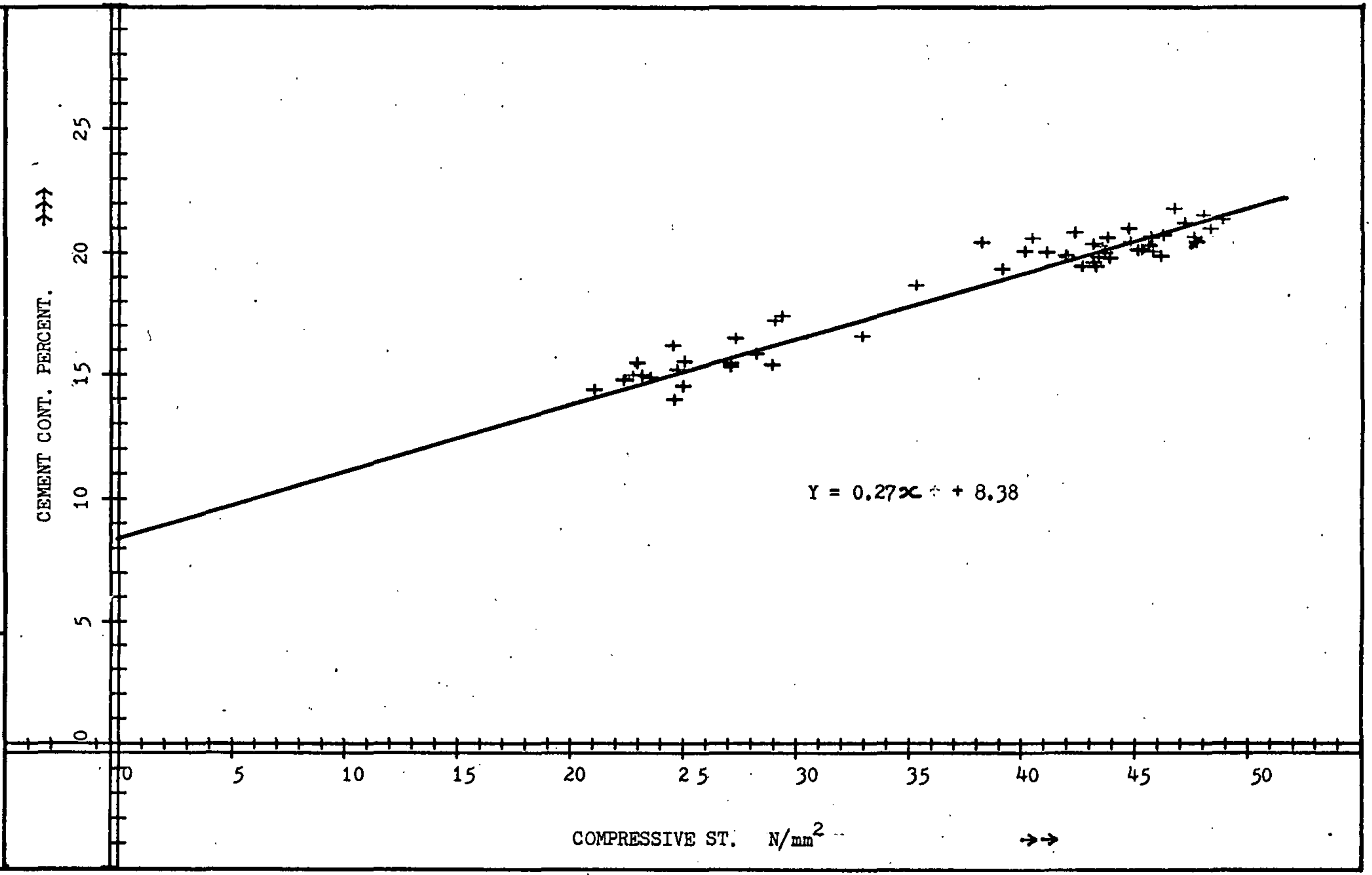

MIX 3 WATER CON T LINER TEST
PLOT 7.9
COEFFICIENT OF VARIATION
0
4
8
12
16
20
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME
SECONDS
CUMFLOW
REVERSING DRUM
ROTARY


MIX 3 CEMENT CON T LINER TESTS
PLOT 7.10
COEFFICIENT OF VARIATION
0
4
8
12
16
20
CUMFLOW
REVERSING DRUM
ROTARY
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME [SECONDS]



MIX 3 COMP ST LINER TESTS

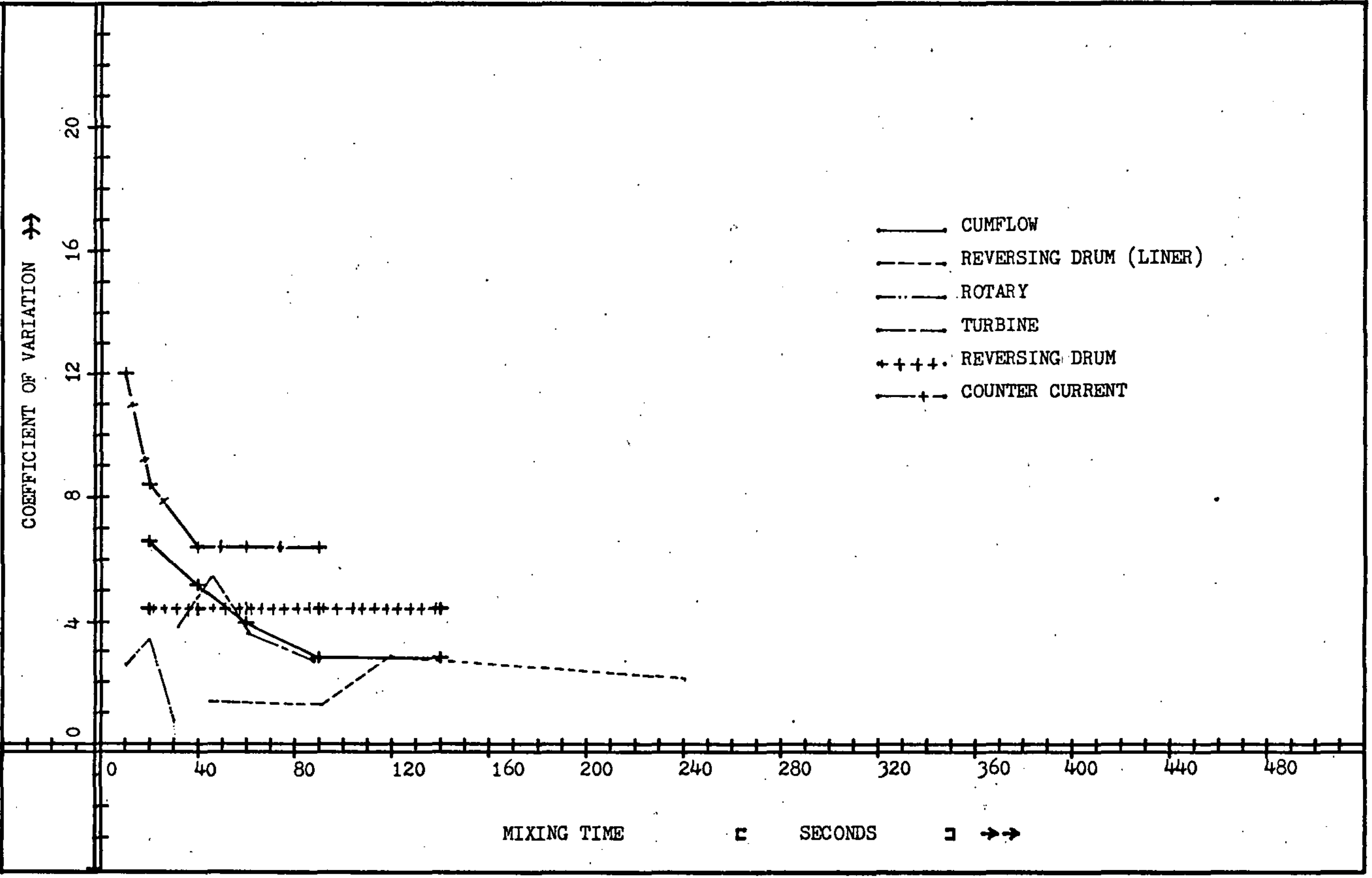
PLOT 7.11



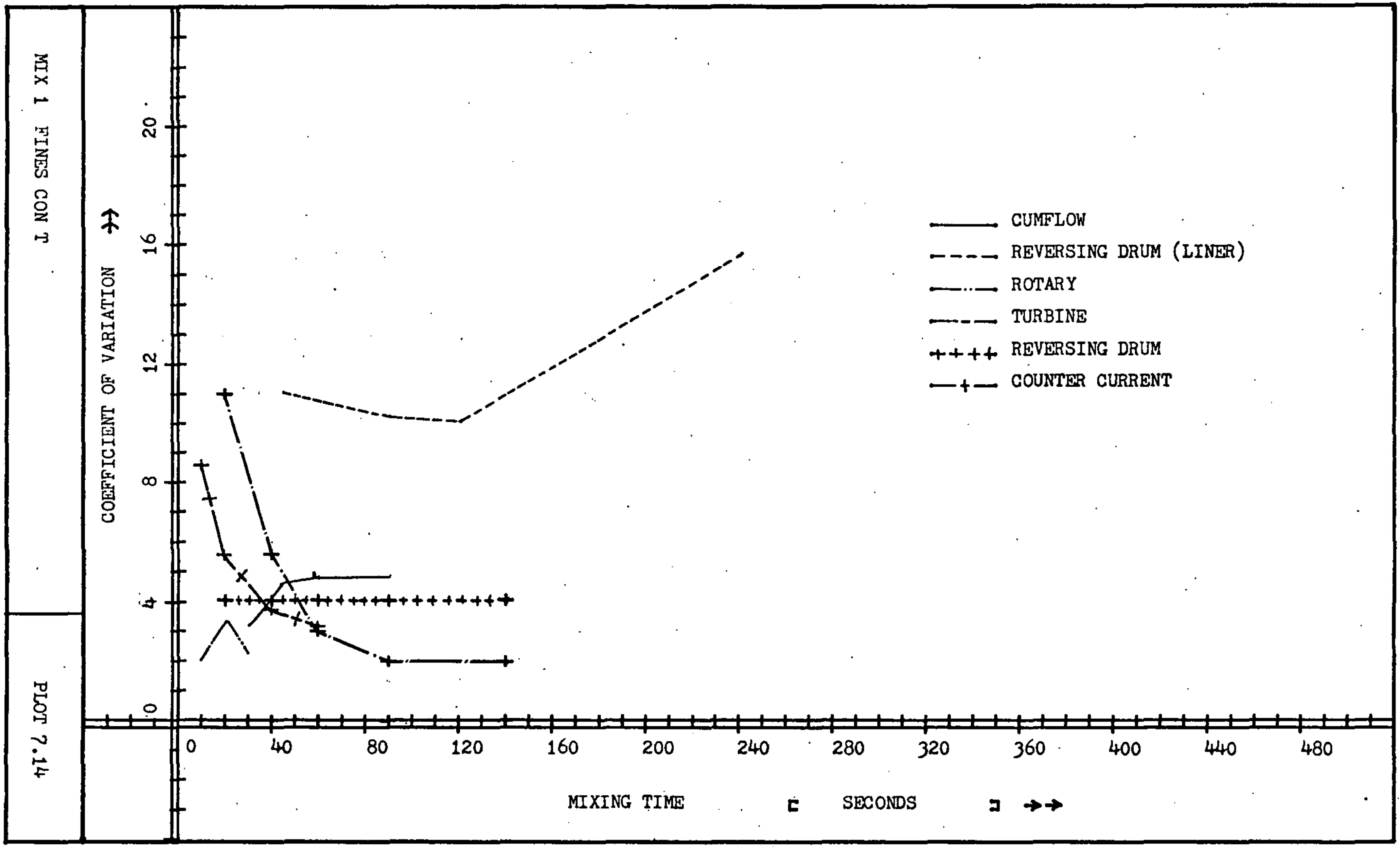
PLOT 7.12

CEMENT CONT AGAINST COMPRESSIVE STRENGTH

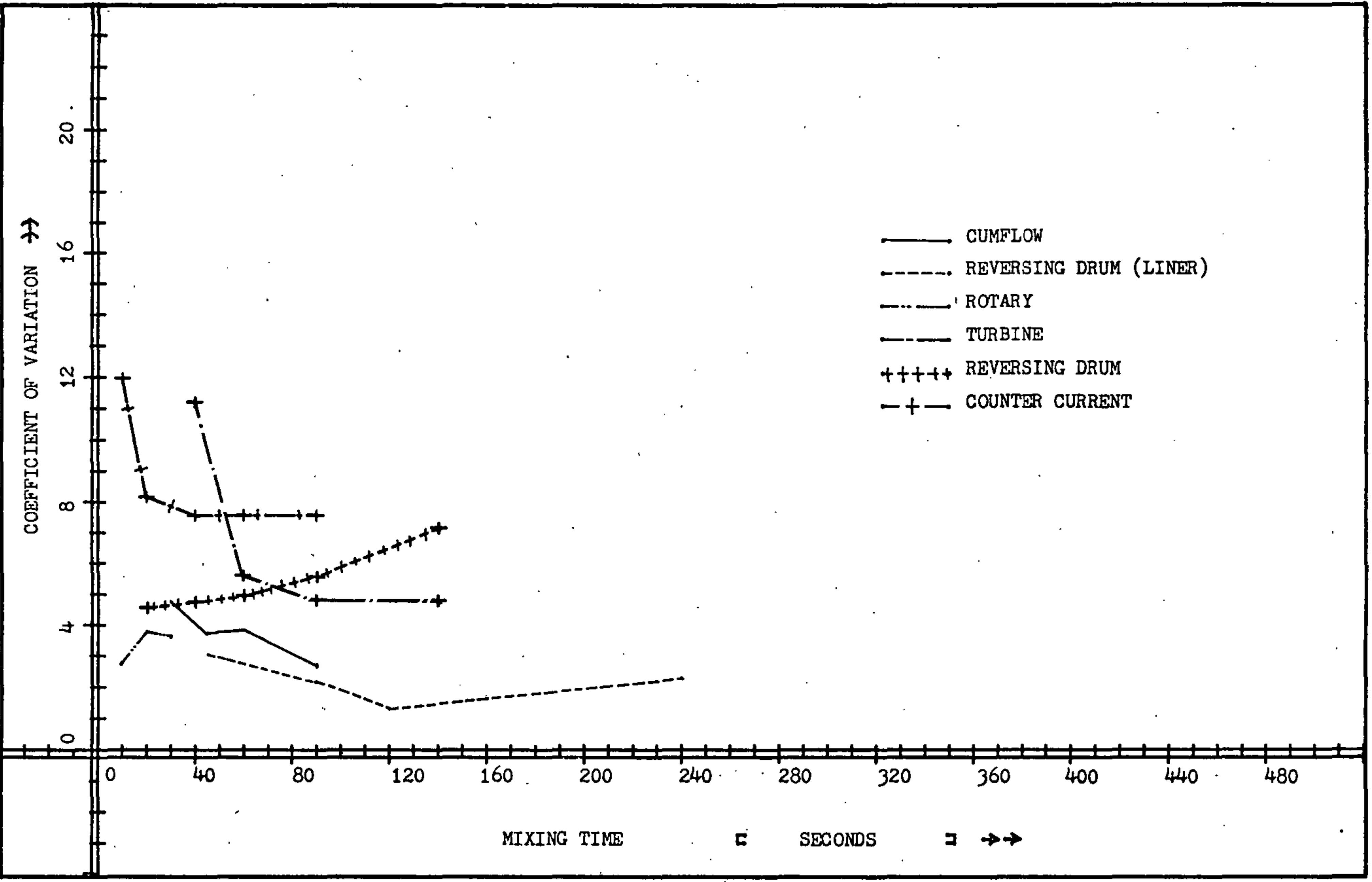
MIX 1 COARSE AGG CON T



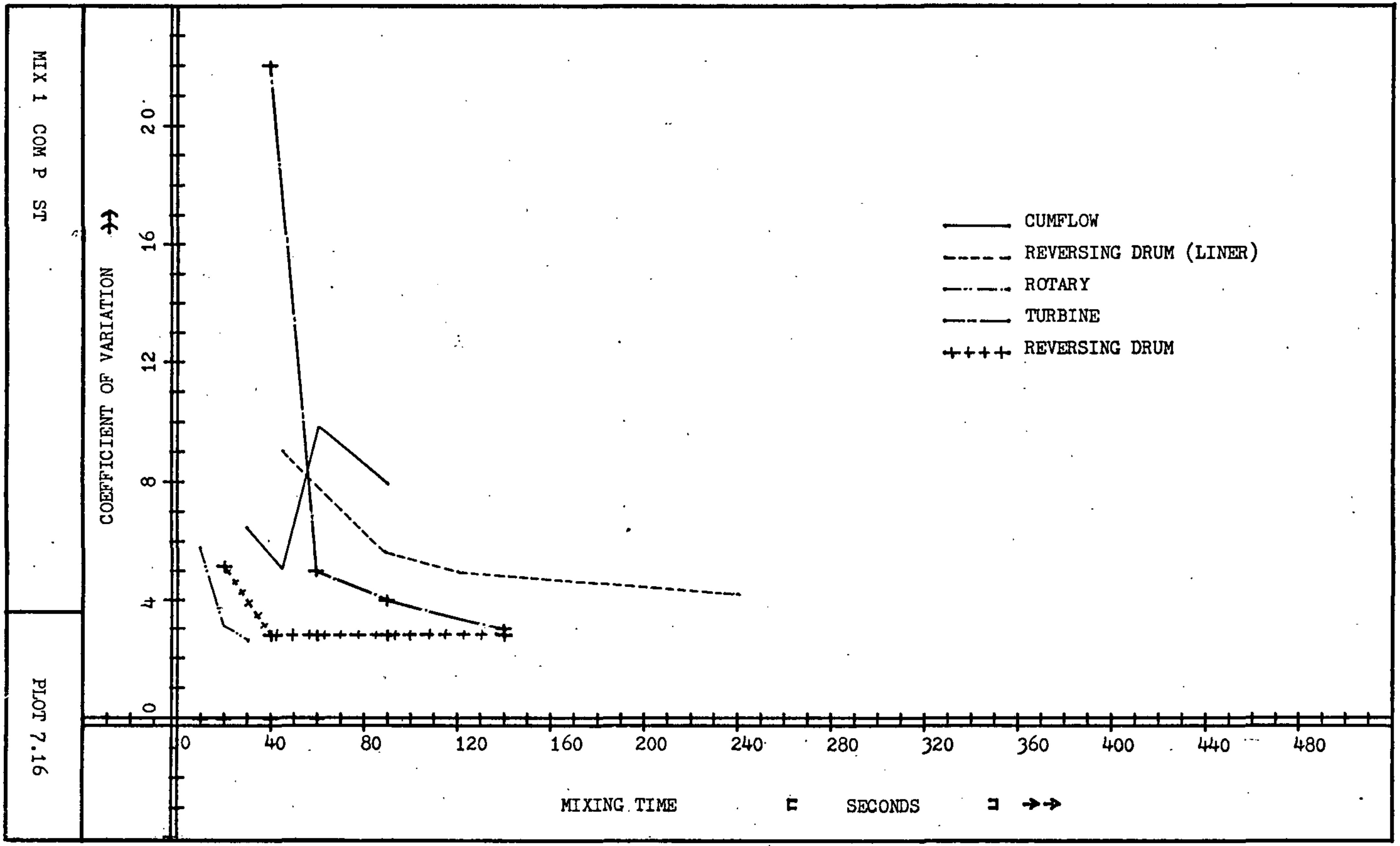
PLOT 7.13


MIX 1 FINES CON T
PLOT 7.14
COEFFICIENT OF VARIATION
0
4
8
12
16
20
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME [SECONDS]
CUMFLOW
REVERSING DRUM (LINER)
ROTARY
TURBINE
REVERSING DRUM
COUNTER CURRENT

MIX 1 CEMENT CON T

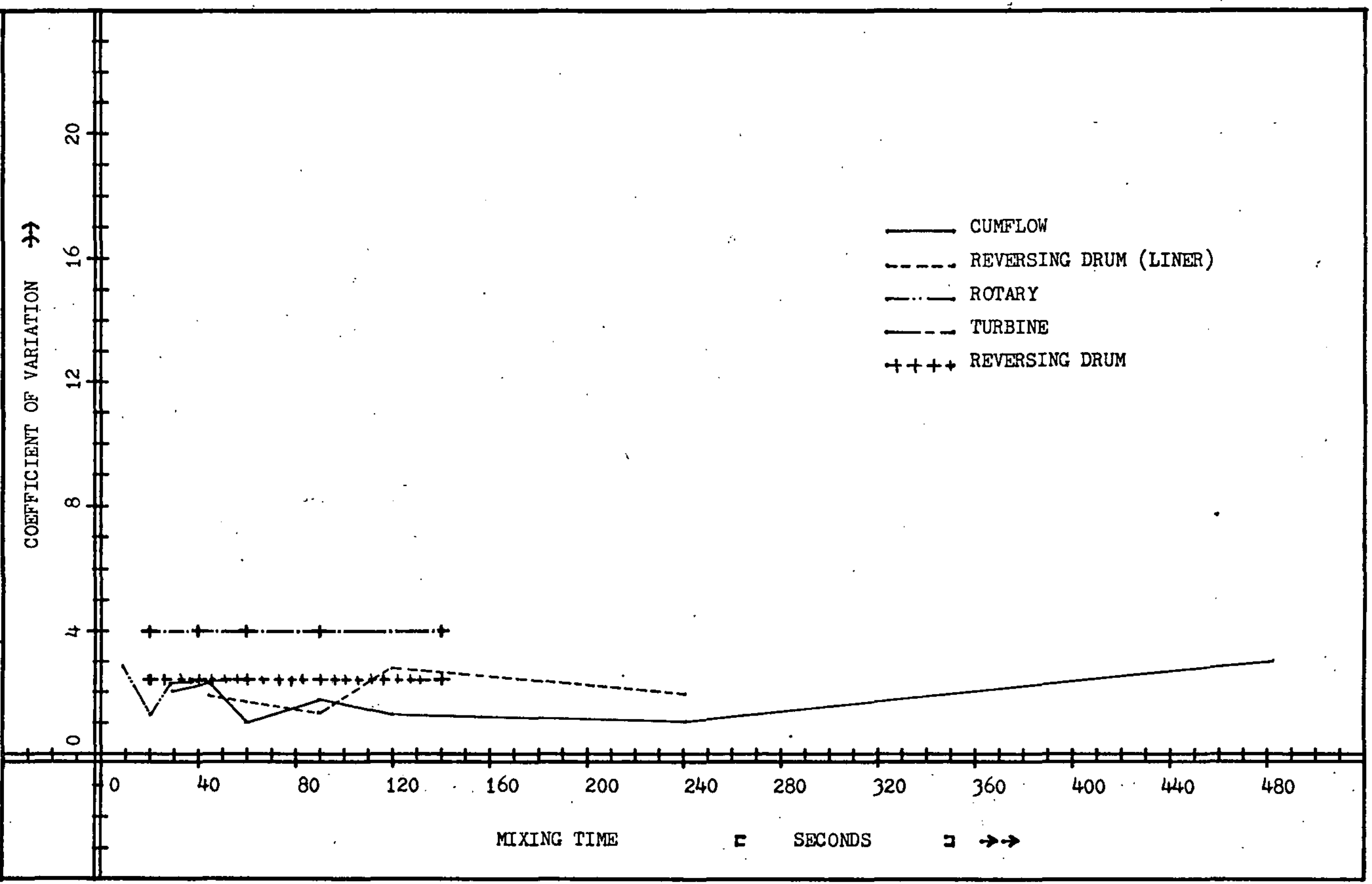


PLOT 7.15



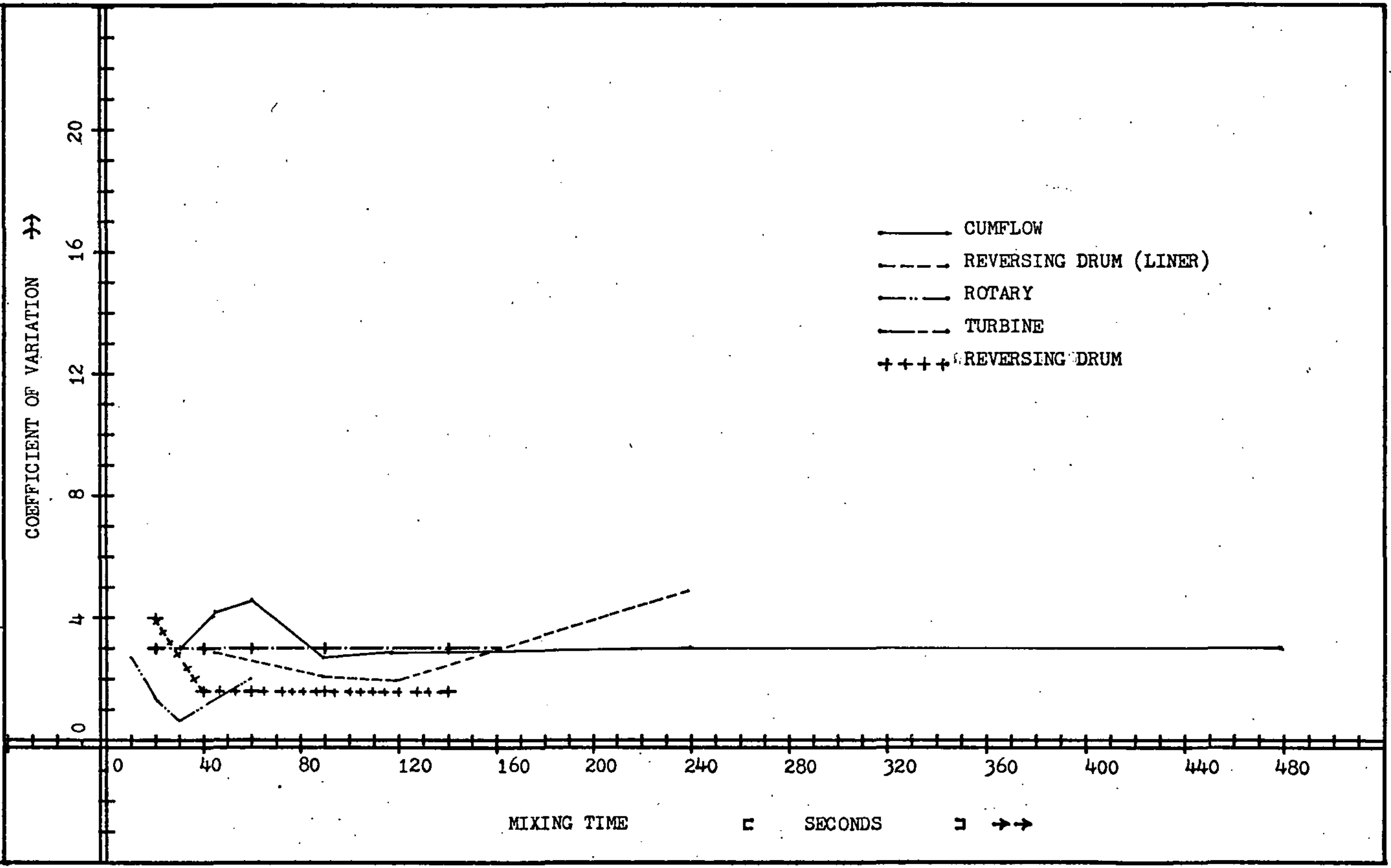
MIX 1 COM P ST
PLOT 7.16
COEFFICIENT OF VARIATION
0
4
8
12
16
20
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME
SECONDS
CUMFLOW
REVERSING DRUM (LINER)
ROTARY
TURBINE
REVERSING DRUM

MIX 3 COARSE AGG CON T

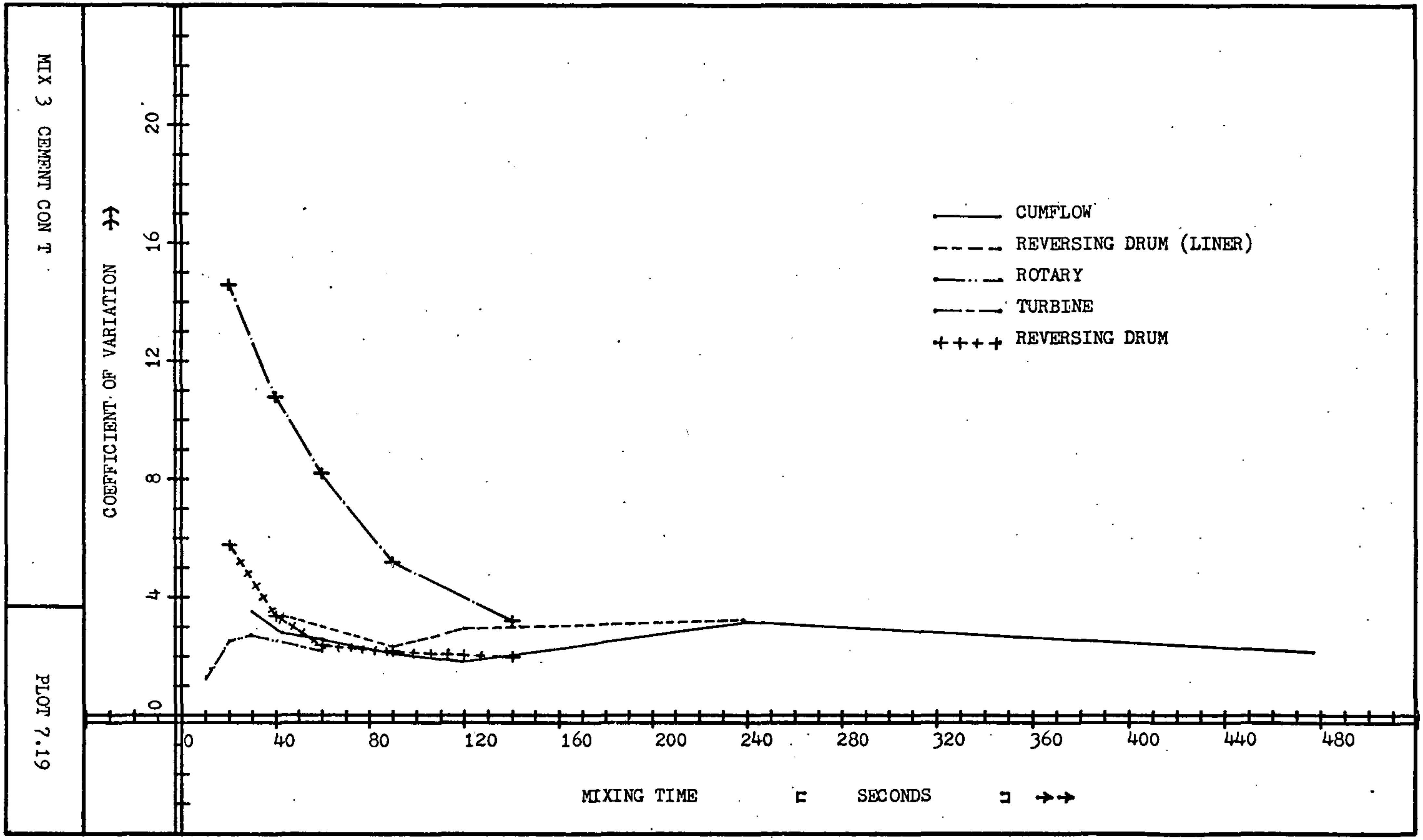


PLOT 7.17

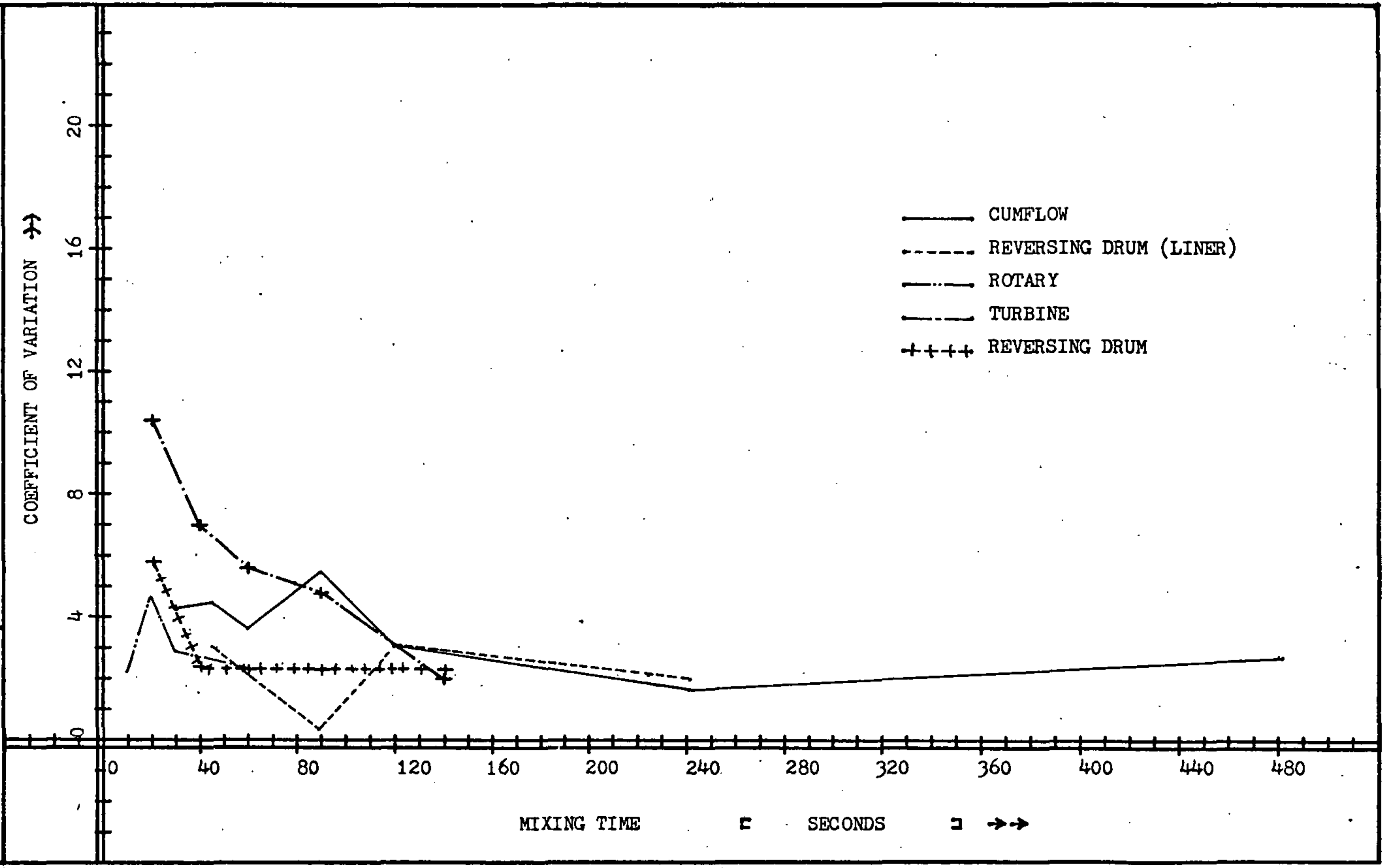
MIX 3 FINES CON T



PLOT 7.18

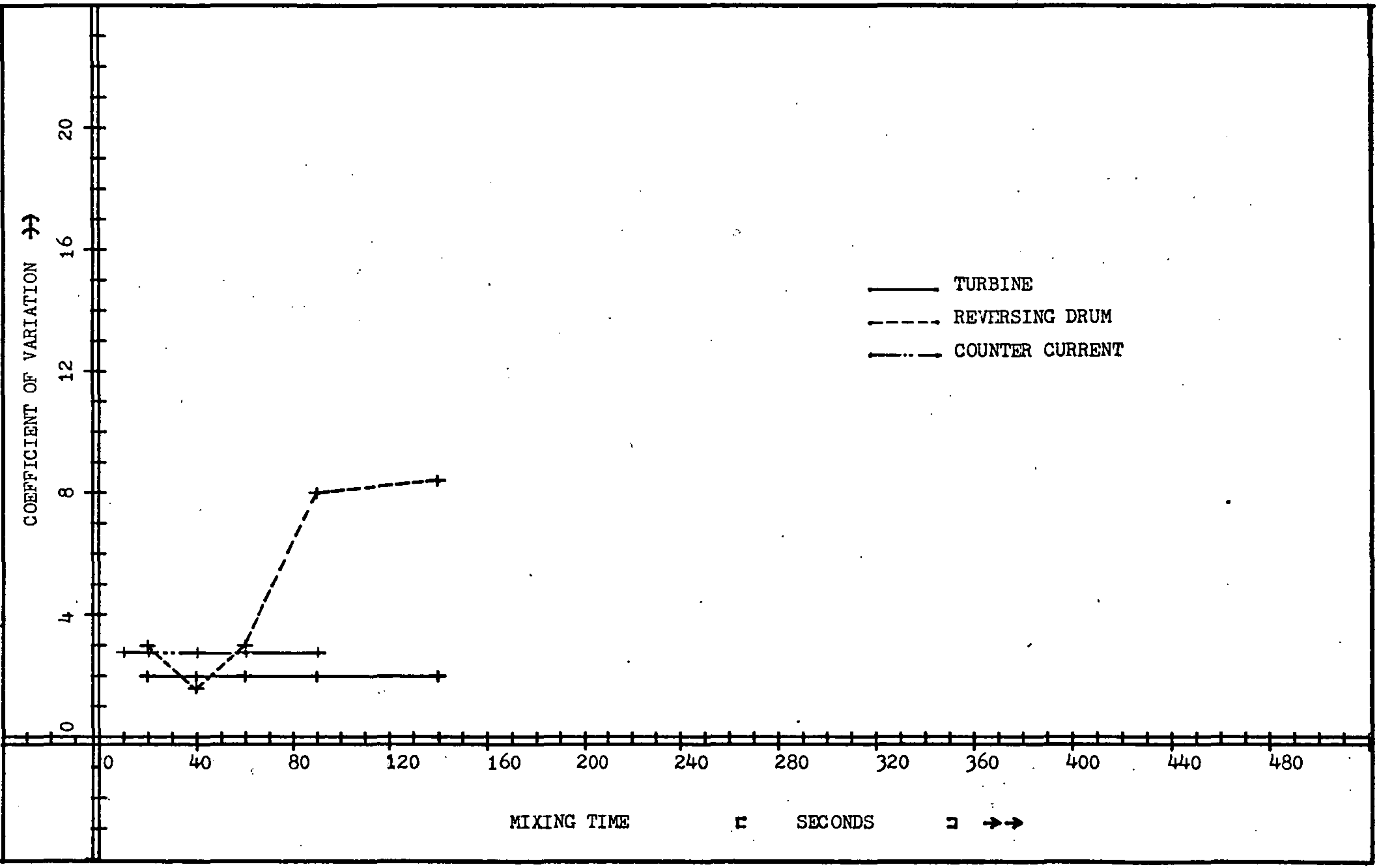

MIX 3 CEMENT CON T
PLOT 7.19
COEFFICIENT OF VARIATION
0
4
8
12
16
20
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME [SECONDS]
CUMFLOW
REVERSING DRUM (LINER)
ROTARY
TURBINE
REVERSING DRUM

MIX 3 COMP ST

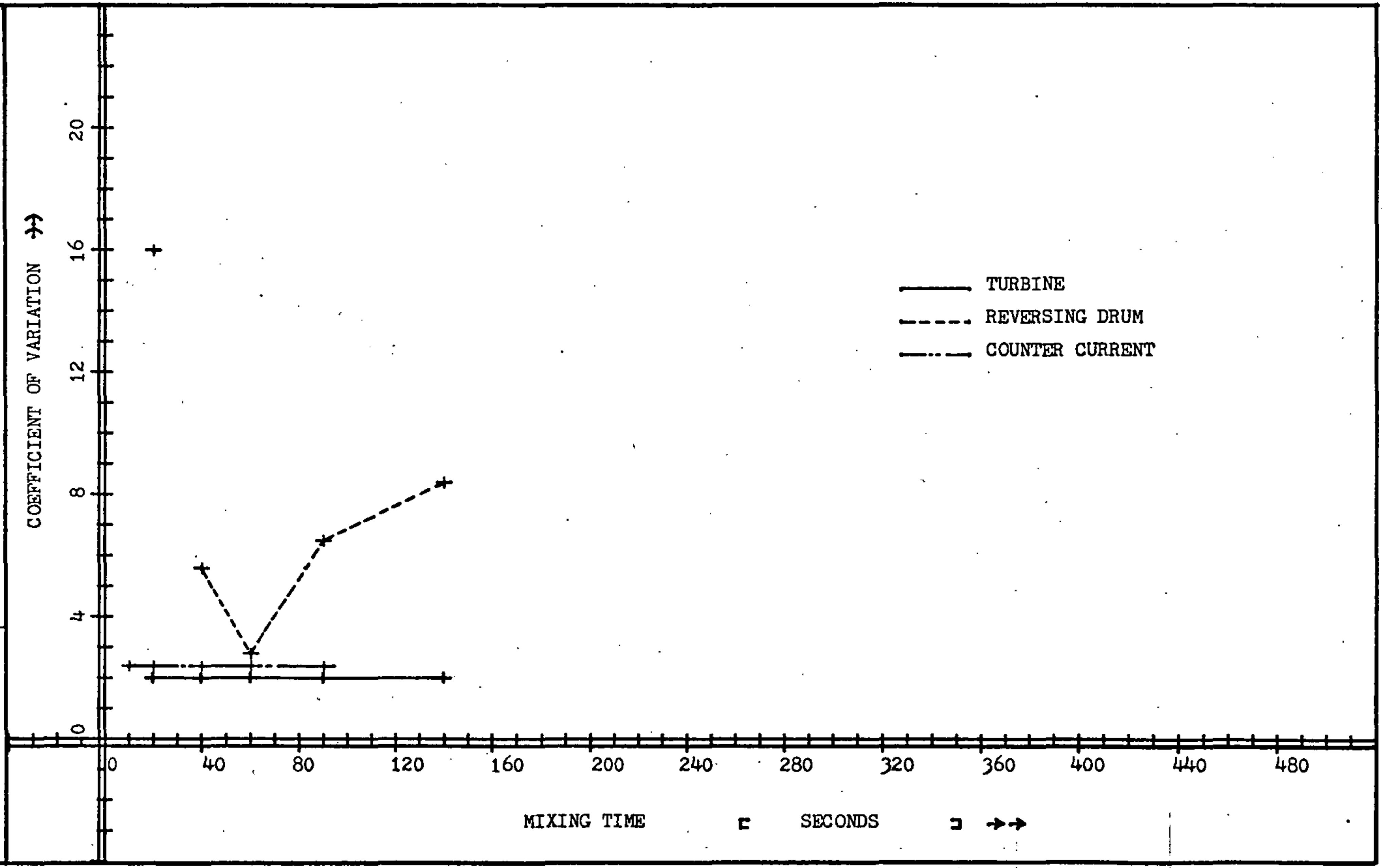


PLOT 7.20

MIX 3 5 m.m. SLUMP COARSE AGG CON T



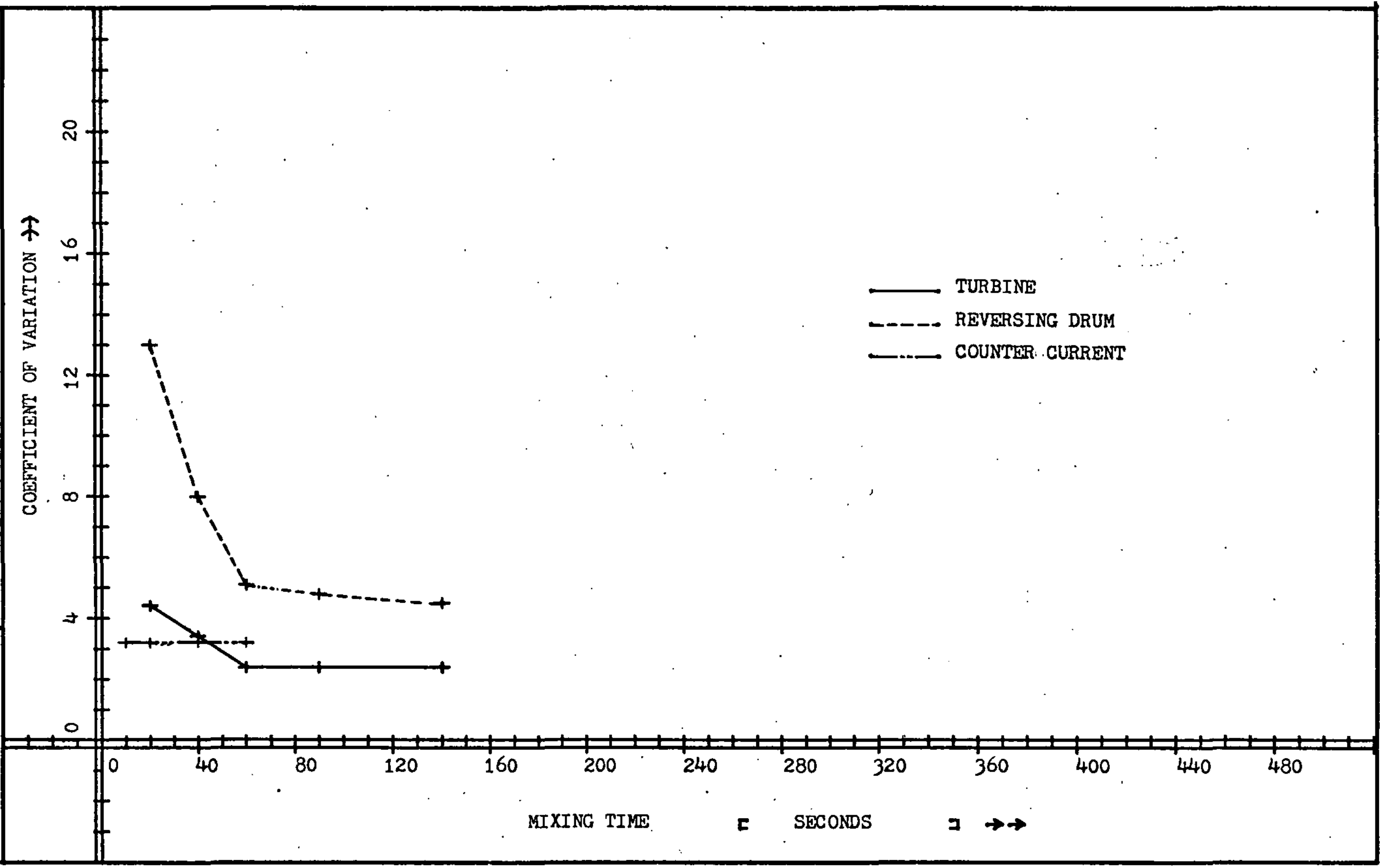
PLOT 7.21



MIX 3 5m.m. SLUMP FINES CON T

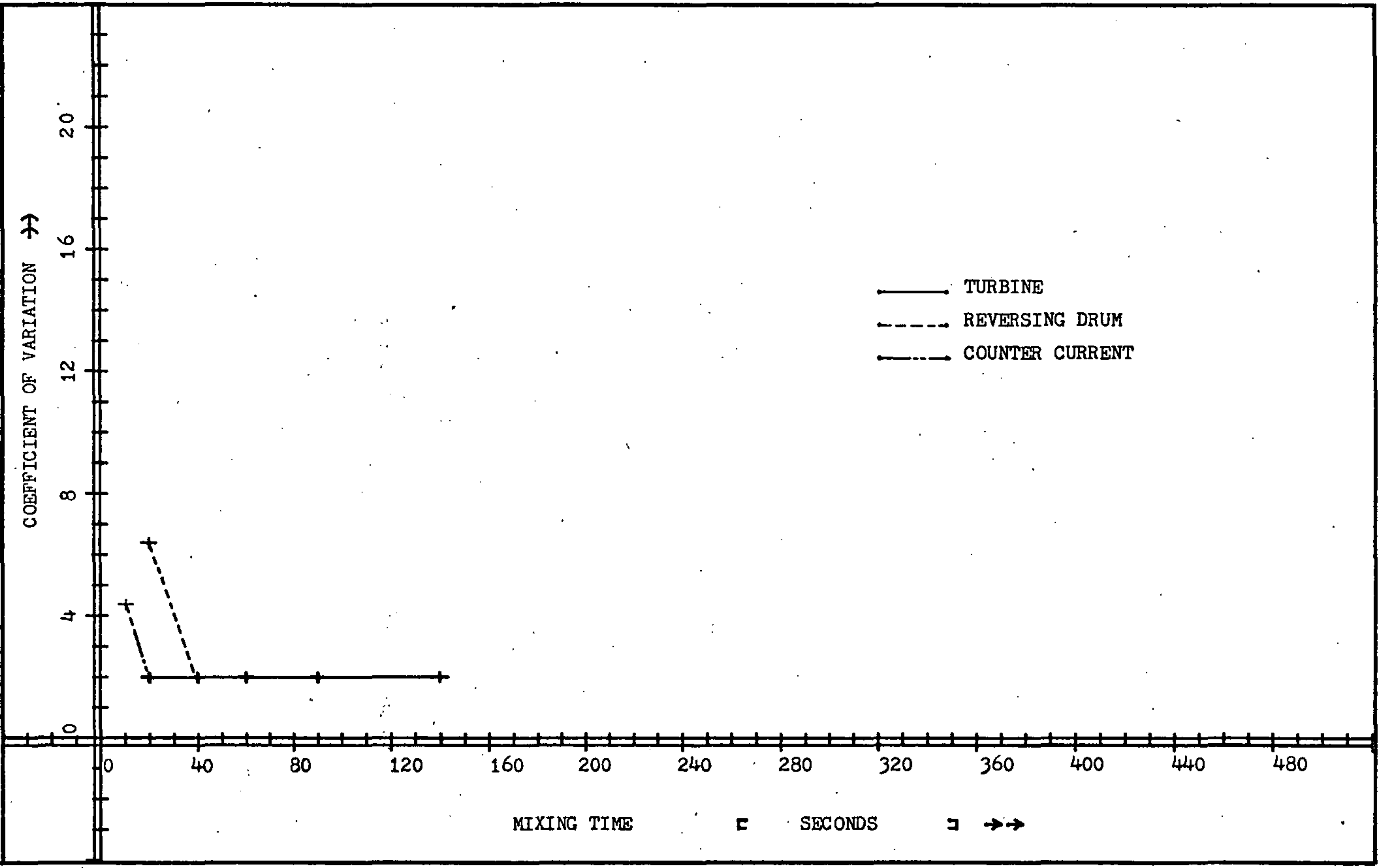
PLOT 7.22

MIX 3 5 m.m. SLUMP CEMENT CON T

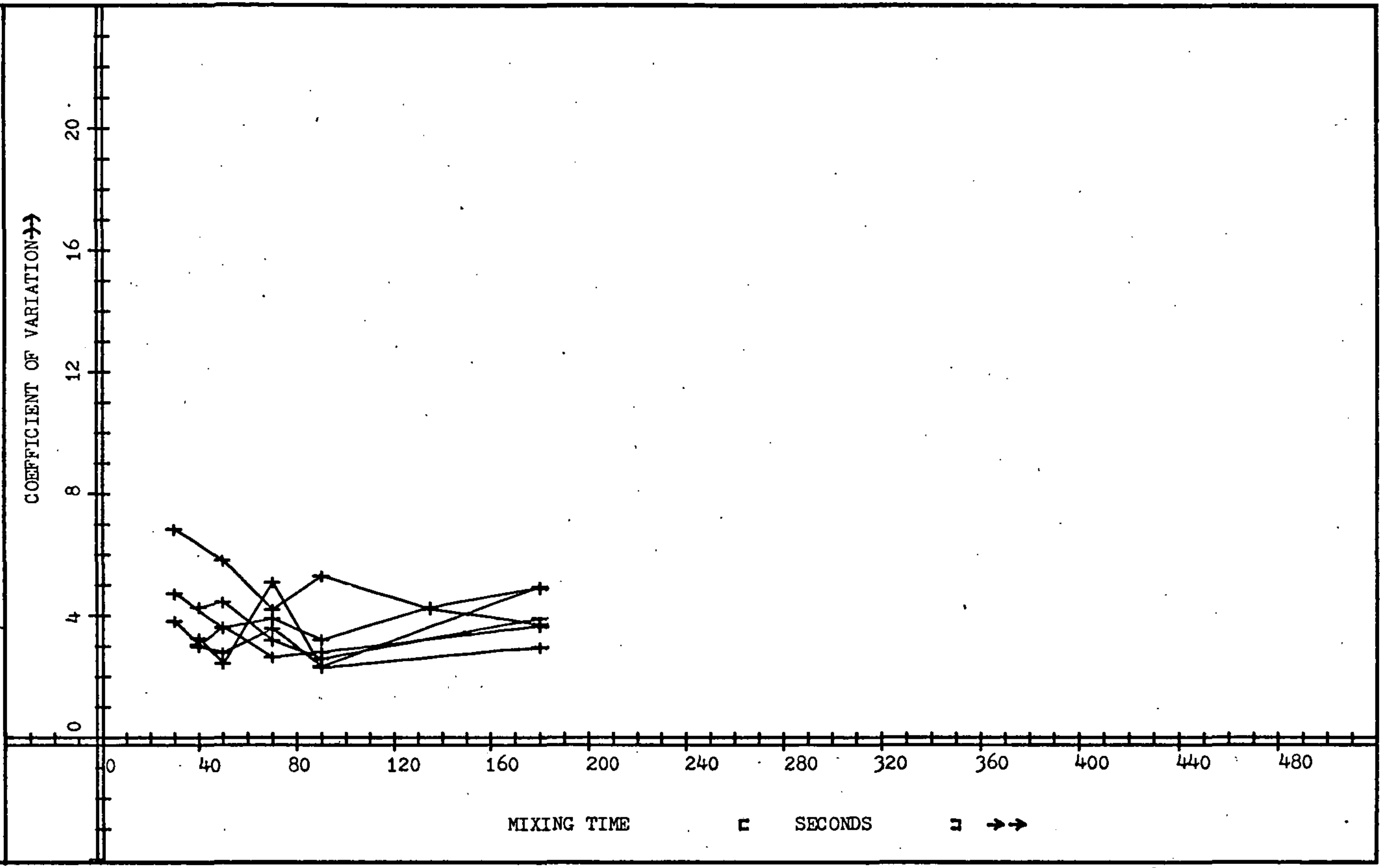


PLOT 7.23

MIX 3 SLUMP 5 m.m. COMP ST

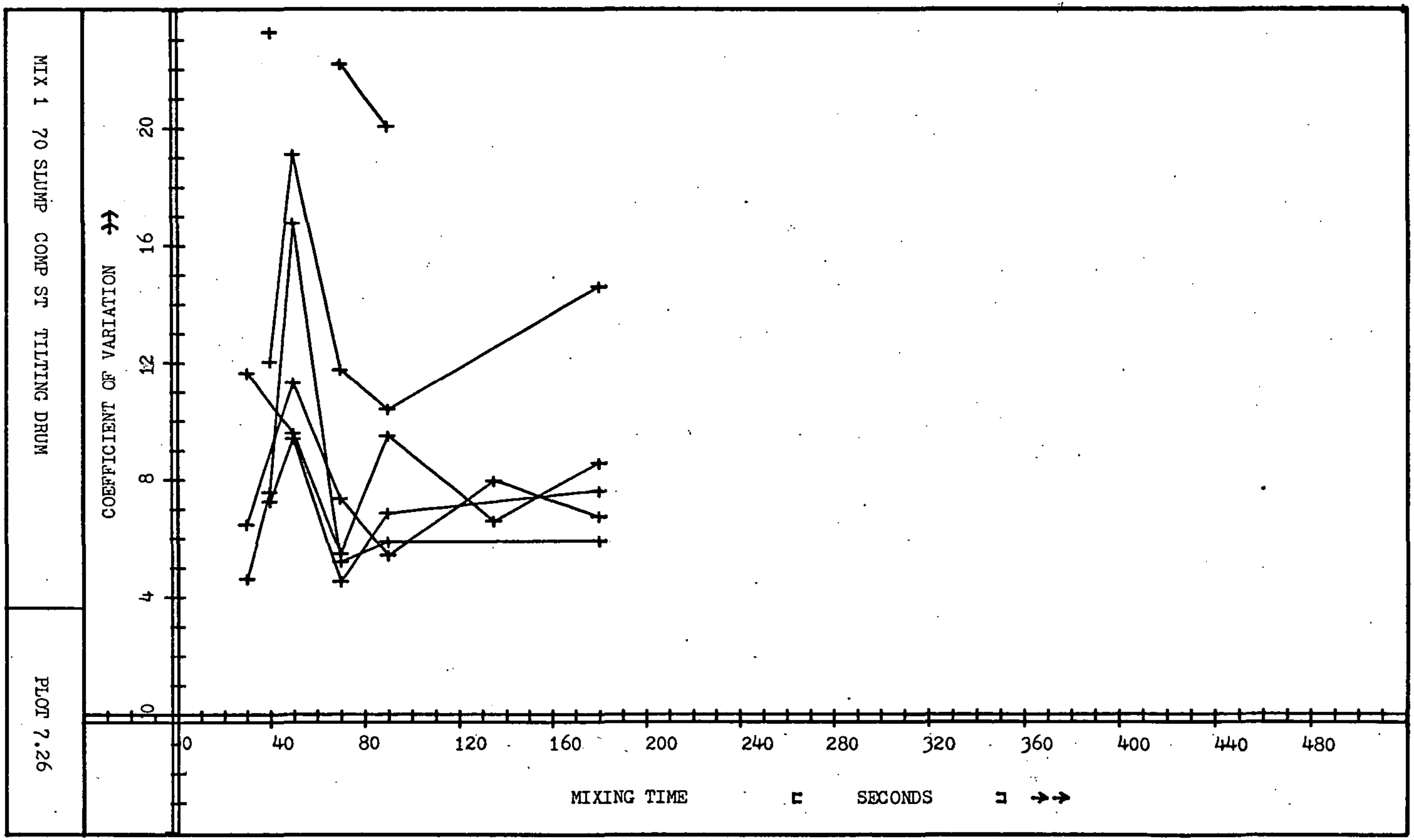


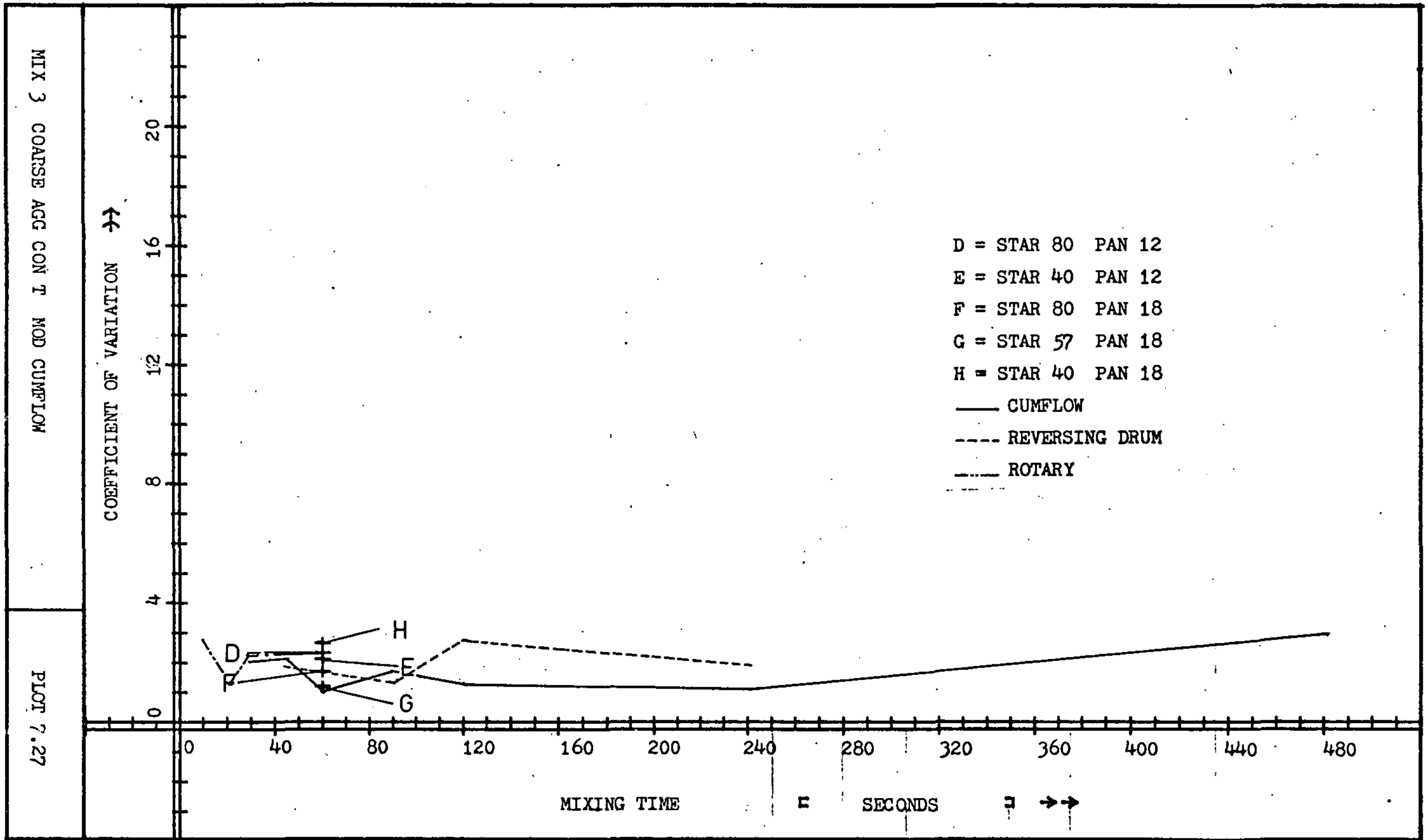
PLOT 7.24

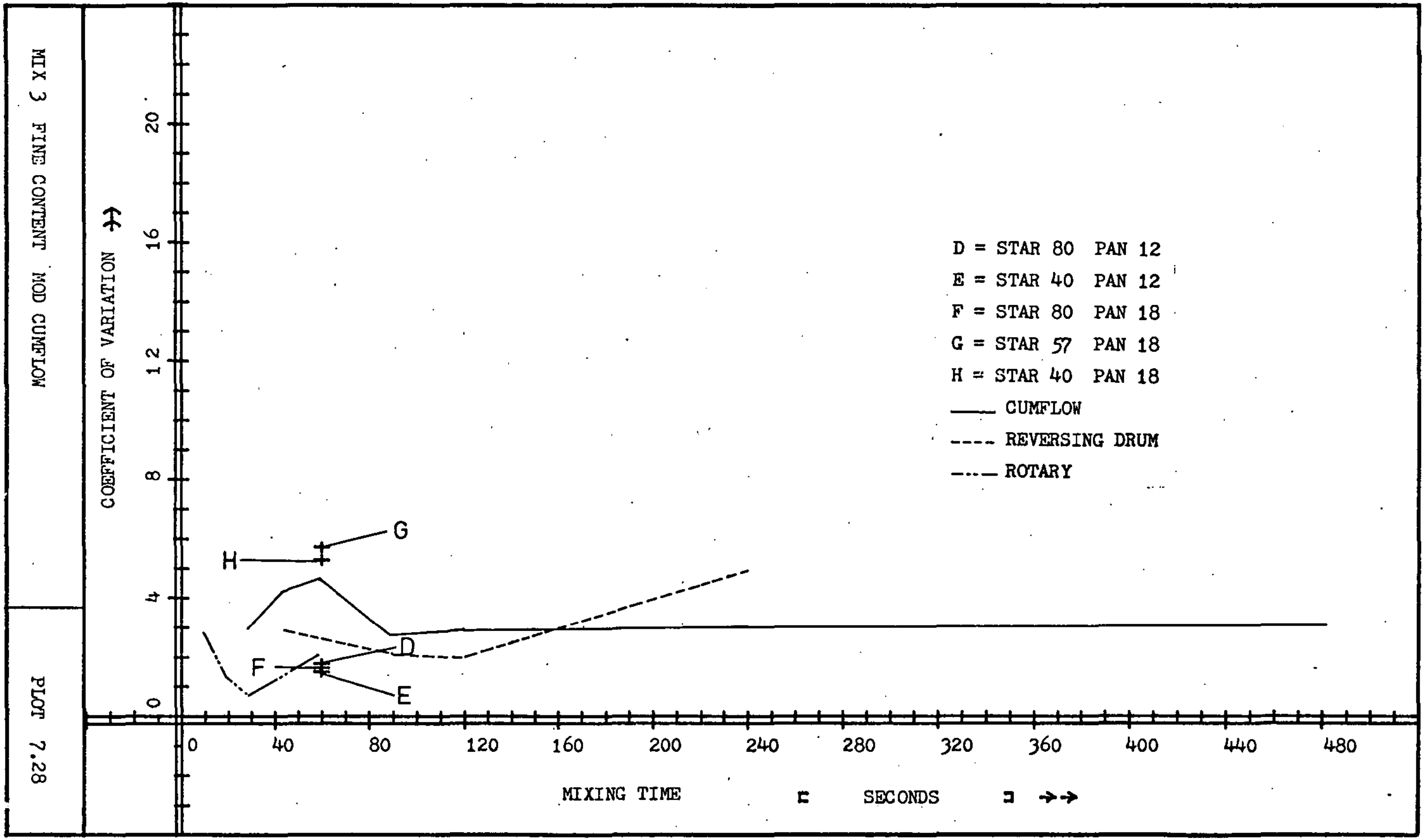


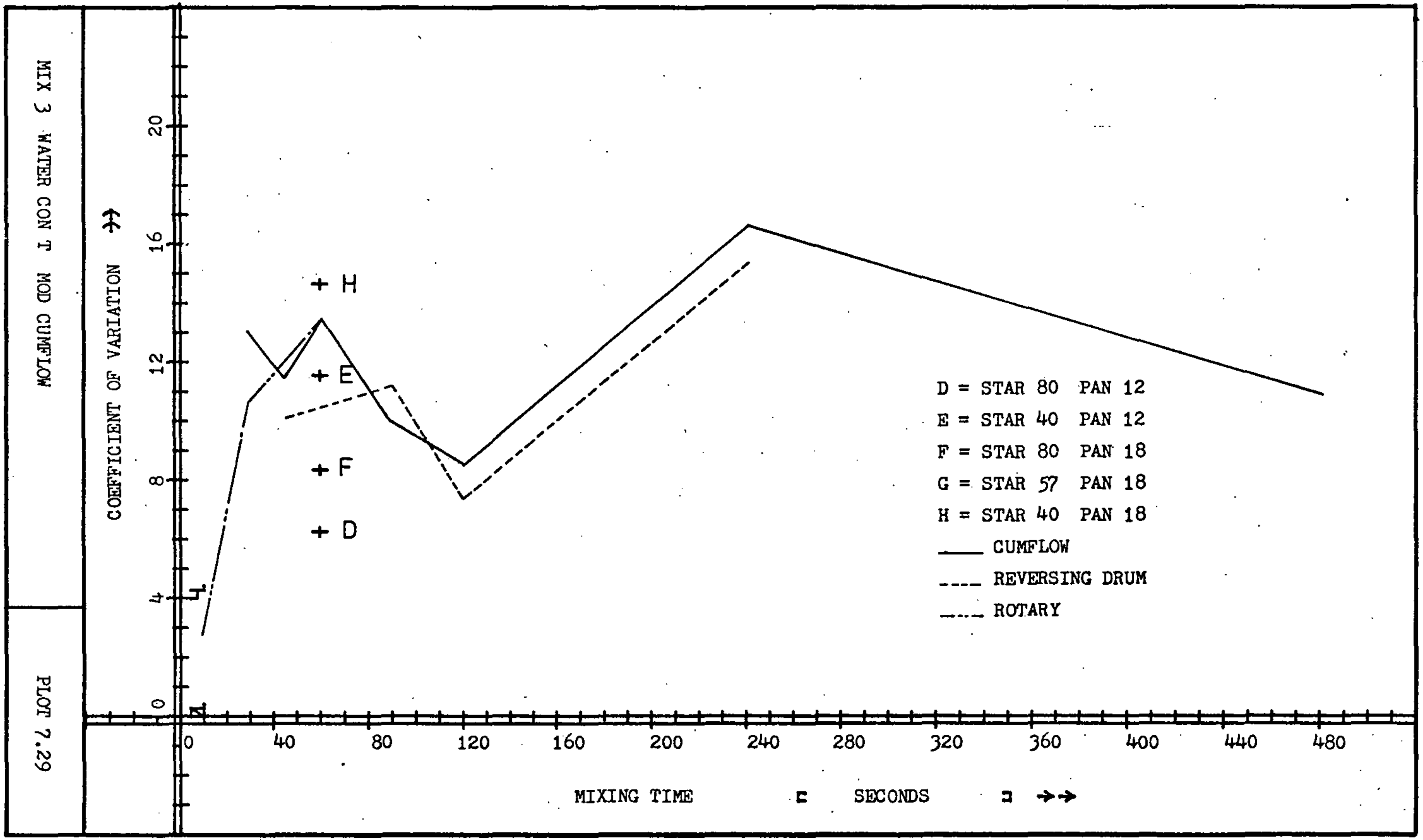
MIX 1 70 SLUMP COARSE AGG TILTING DRUM

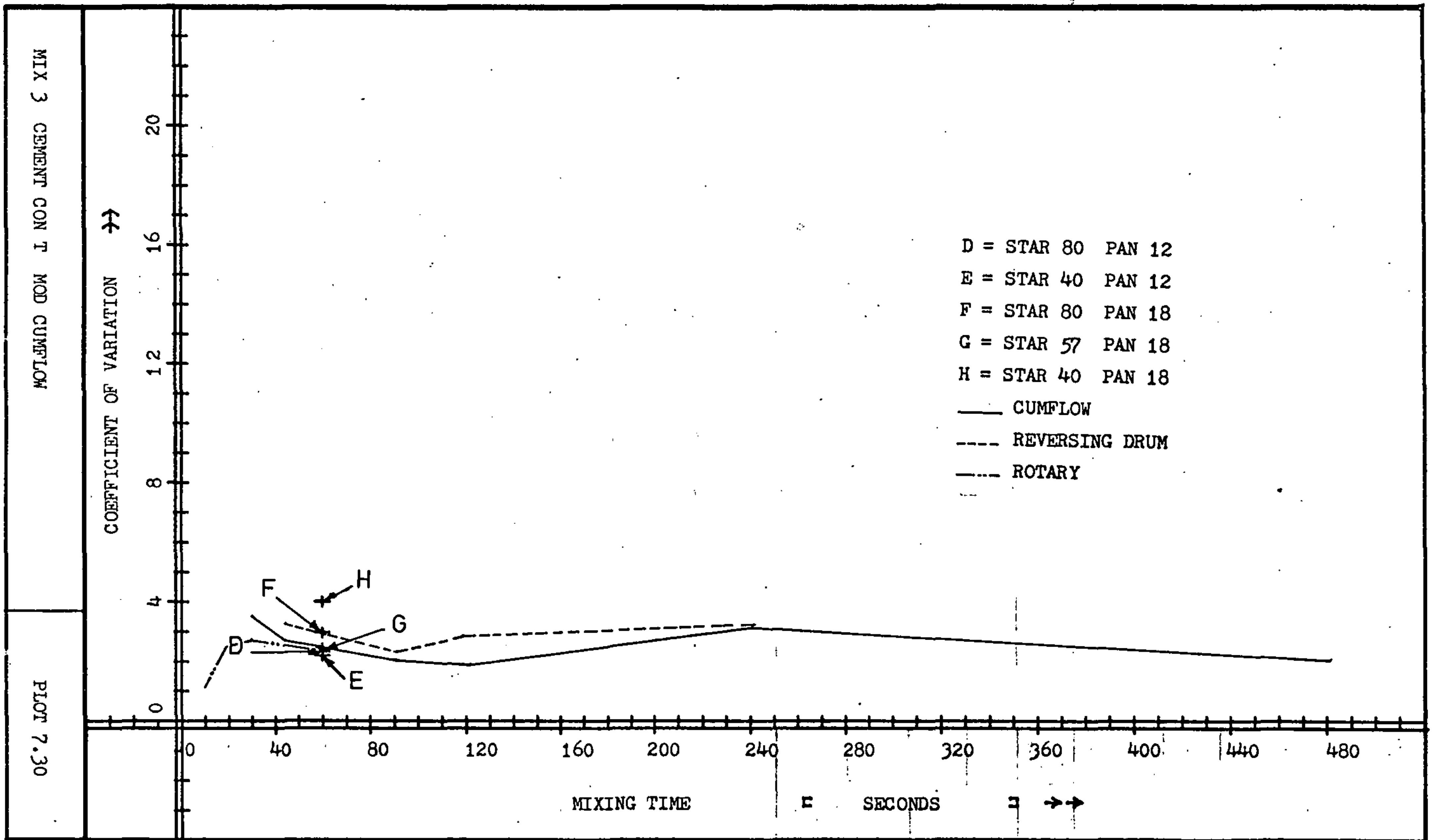
PLOT 7.25


MIX 1 70 SLUMP COMP ST TILTING DRUM
PLOT 7.26
COEFFICIENT OF VARIATION
0
4
8
12
16
20
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME [SECONDS]


MIX 3 COARSE AGG CON T MOD CUMFLOW
PLOT 7.27
COEFFICIENT OF VARIATION
0
4
8
12
16
20
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME
SECONDS
D
E
F
G
H
D = STAR 80 PAN 12
E = STAR 40 PAN 12
F = STAR 80 PAN 18
G = STAR 57 PAN 18
H = STAR 40 PAN 18
CUMFLOW
REVERSING DRUM
ROTARY


MIX 3 FINE CONTENT MOD CUMFLOW
PLOT 7.28
COEFFICIENT OF VARIATION →
0
4
8
12
16
20
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME [SECONDS] →
D = STAR 80 PAN 12
E = STAR 40 PAN 12
F = STAR 80 PAN 18
G = STAR 57 PAN 18
H = STAR 40 PAN 18
CUMFLOW
REVERSING DRUM
ROTARY
G
H
D
F
E

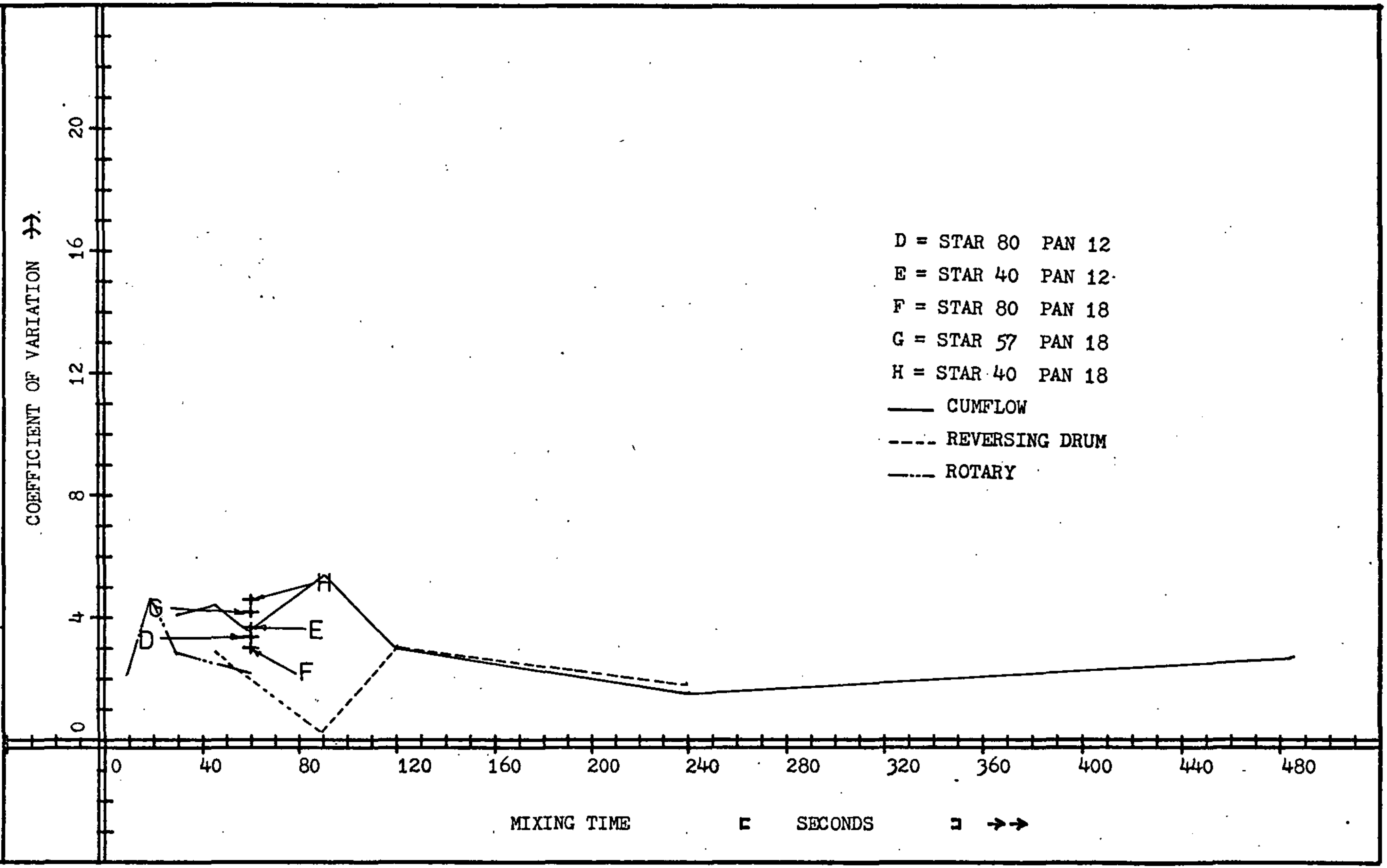

MIX 3 WATER CON T MOD CUMFLOW
PLOT 7.29
COEFFICIENT OF VARIATION
0
4
8
12
16
20
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME [SECONDS]
H
E
F
D
D = STAR 80 PAN 12
E = STAR 40 PAN 12
F = STAR 80 PAN 18
G = STAR 57 PAN 18
H = STAR 40 PAN 18
CUMFLOW
REVERSING DRUM
ROTARY



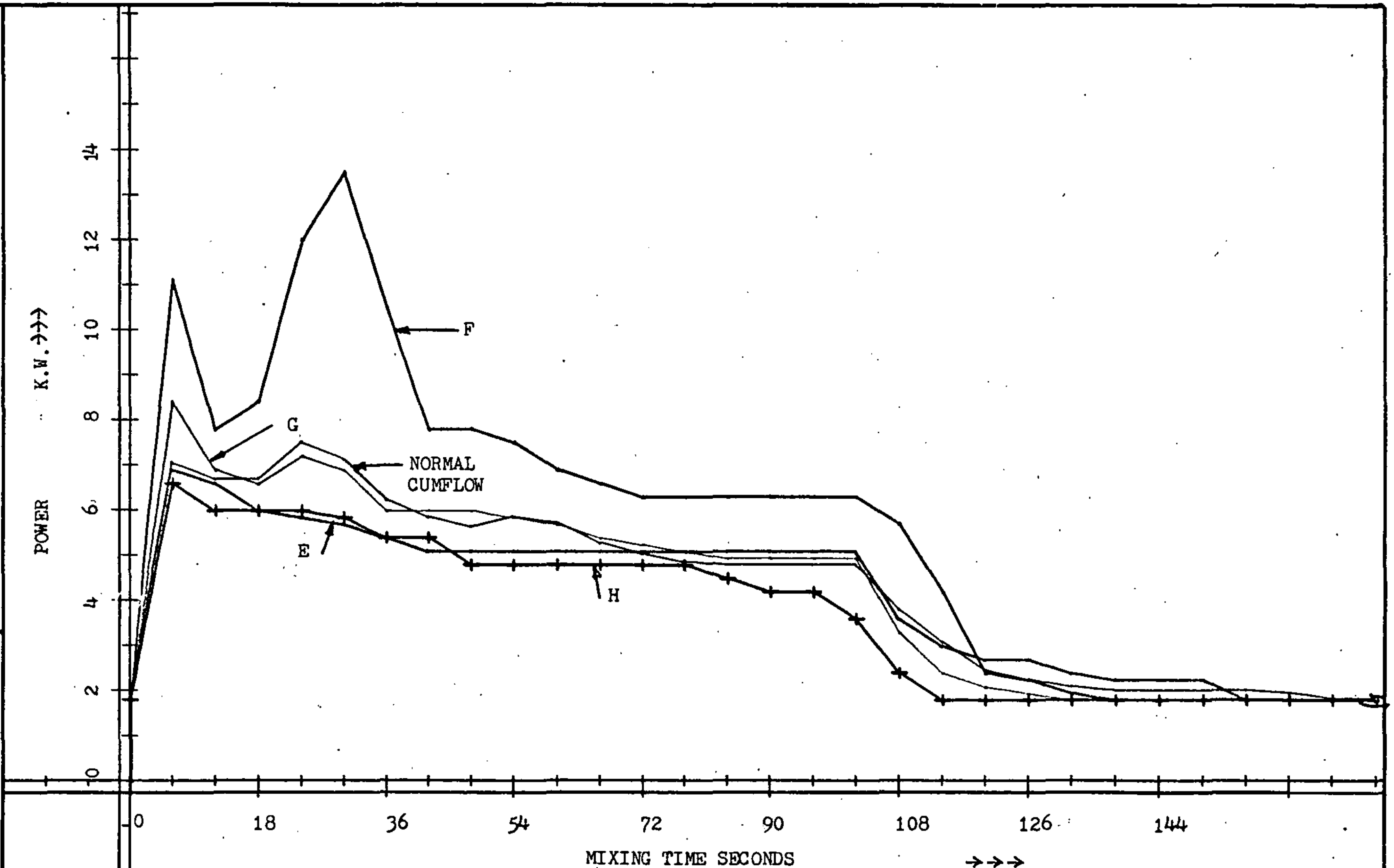
MIX 3 CEMENT CON T MOD CUMFLOW
PLOT 7.30
COEFFICIENT OF VARIATION
0
4
8
12
16
20
0
40
80
120
160
200
240
280
320
360
400
440
480
MIXING TIME [SECONDS]
D = STAR 80 PAN 12
E = STAR 40 PAN 12
F = STAR 80 PAN 18
G = STAR 57 PAN 18
H = STAR 40 PAN 18
CUMFLOW
REVERSING DRUM
ROTARY
D
E
F
G
H

PLOT 7.31

MIX 3 COM P ST MOD CUMFLOW

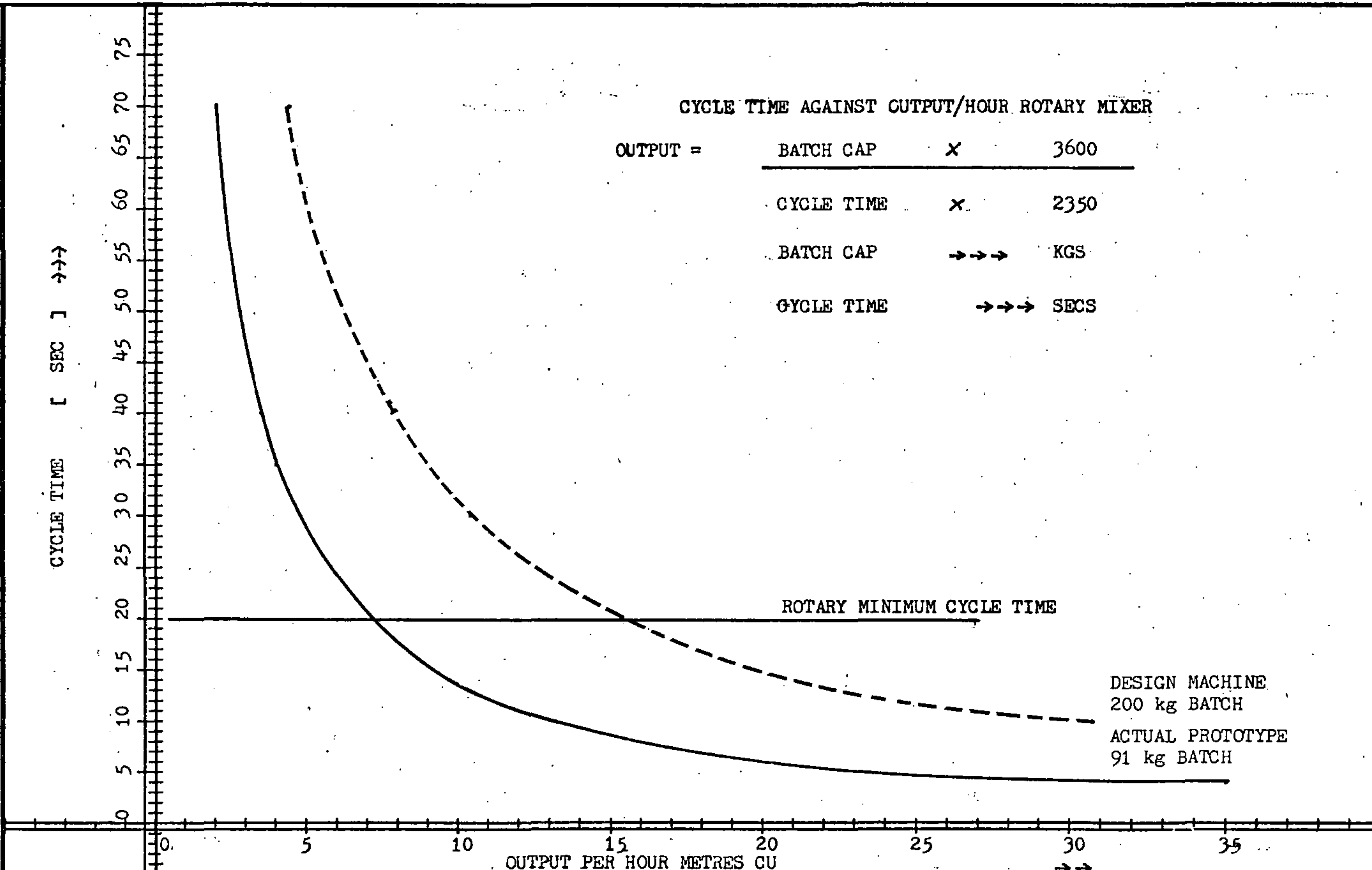


POWER USED AGAINST MIXING TIME



PLOT 7.32

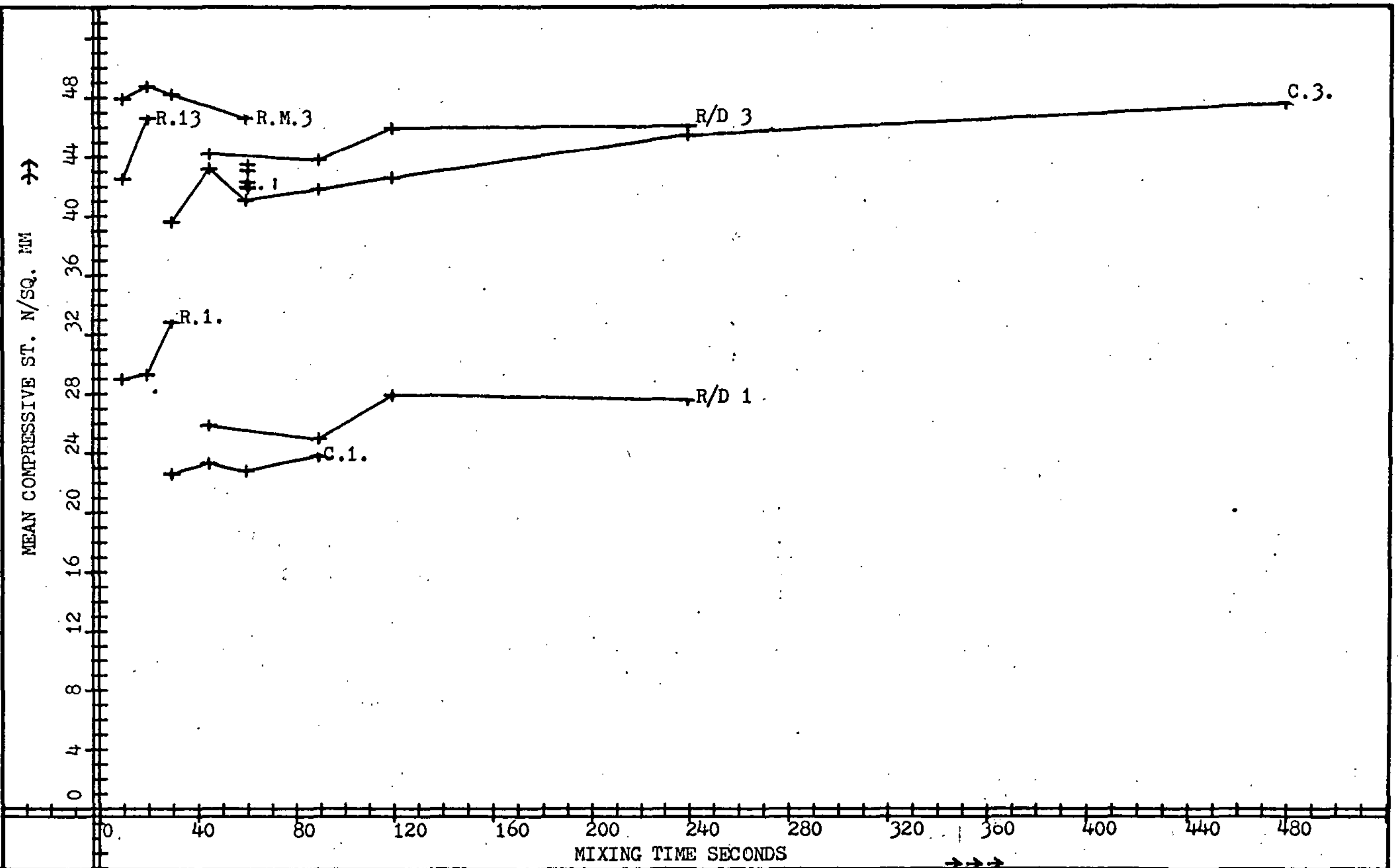
CYCLE TIME AGAINST OUTPUT/HOUR m^3

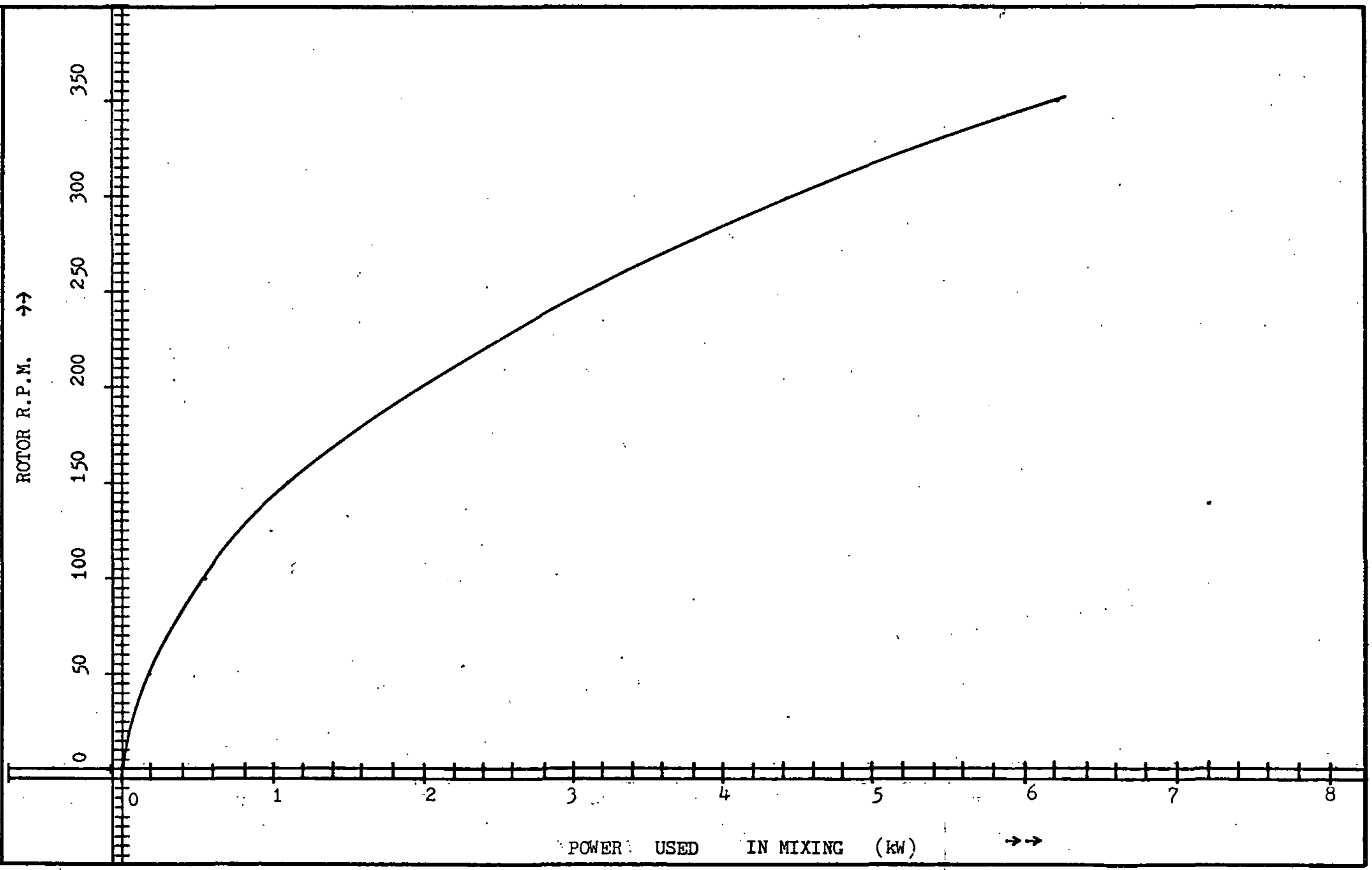


PLOT 7.33

PLOT 7.34

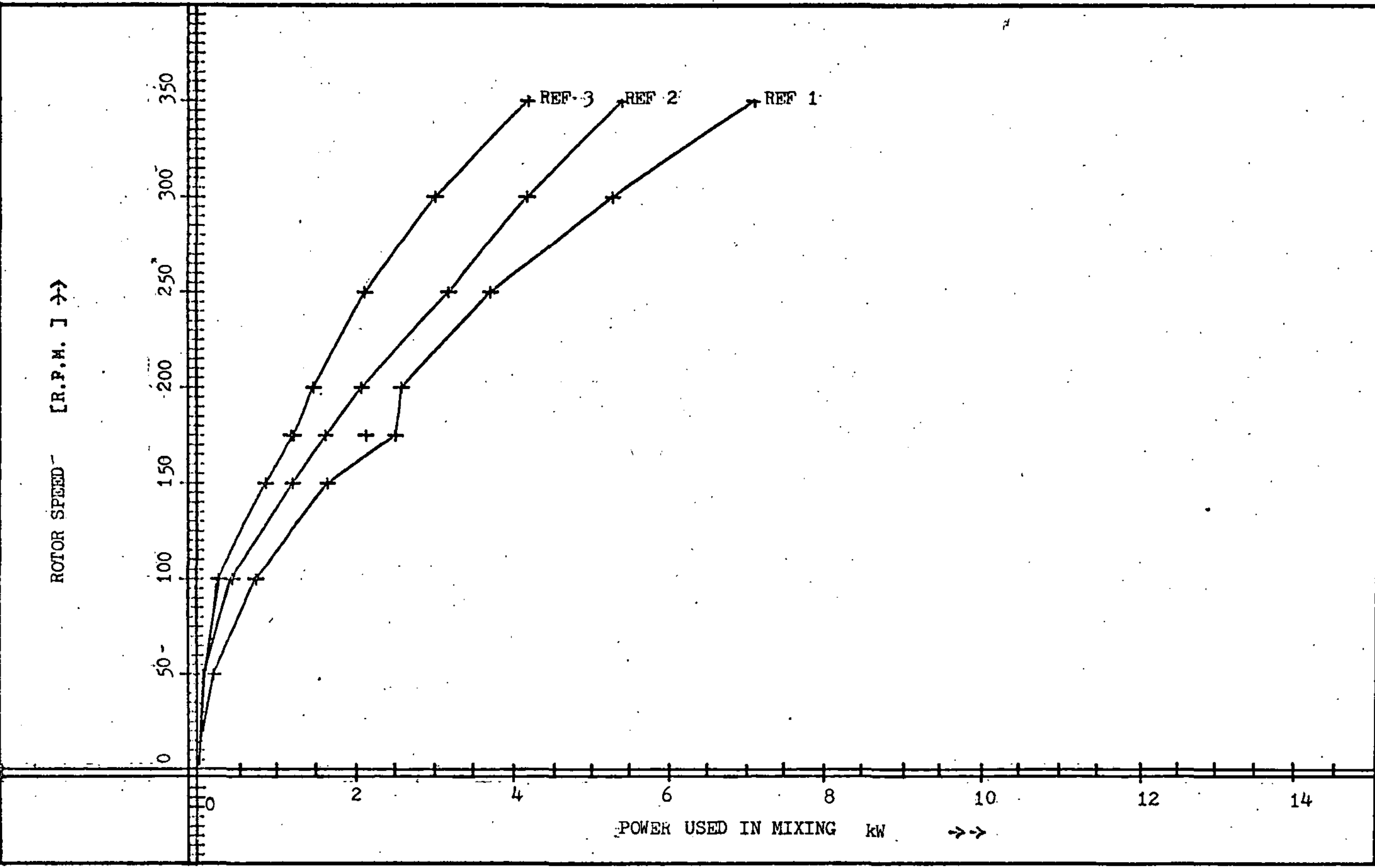
MEAN COMPRESSIVE STRENGTH AGAINST MIXING TIME





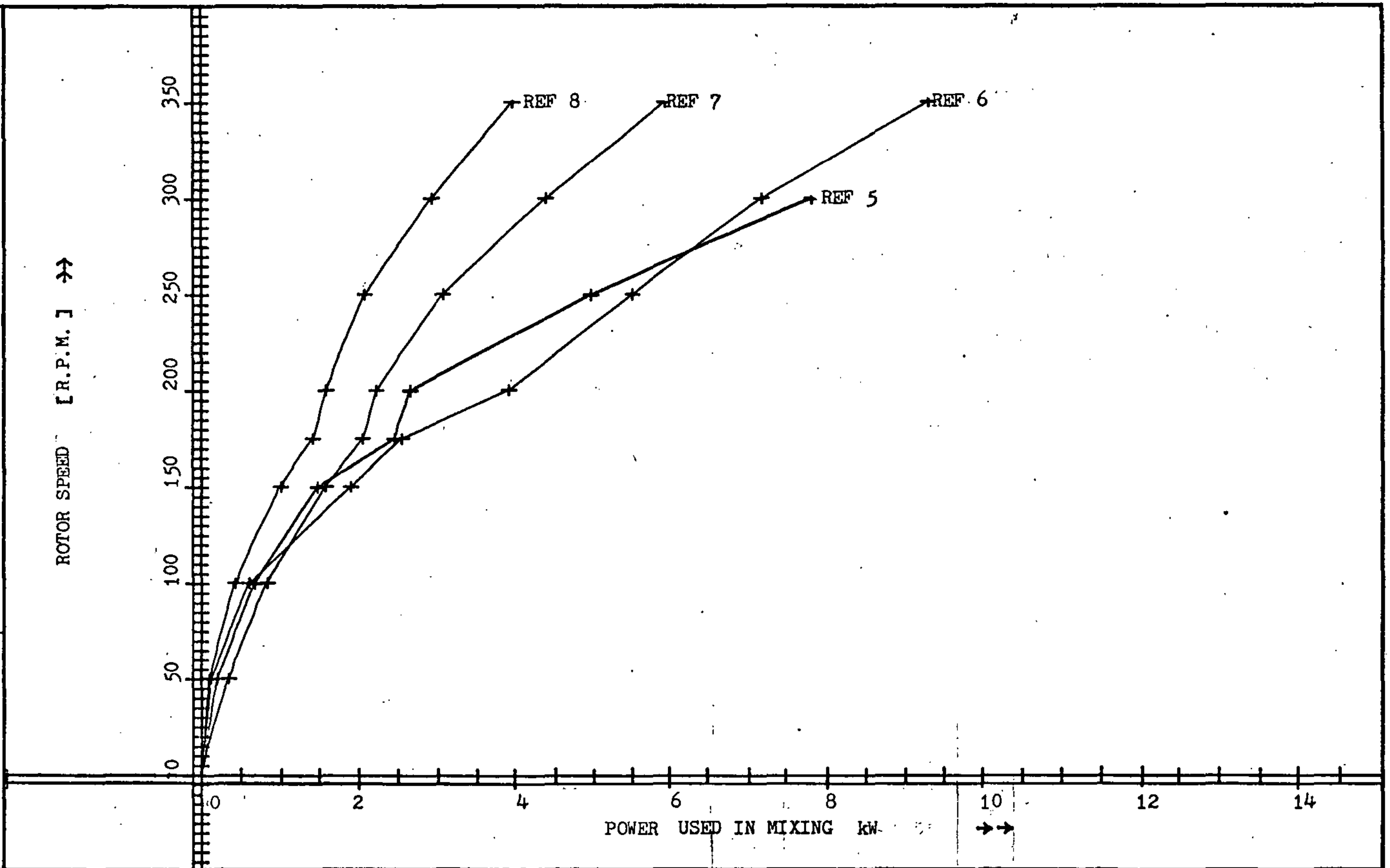
PLOT 8.1

ROTOR R.P.M. AGAINST POWER



PLOT 8.2

ROTOR SPEED AGAINST POWER USED IN MIXING

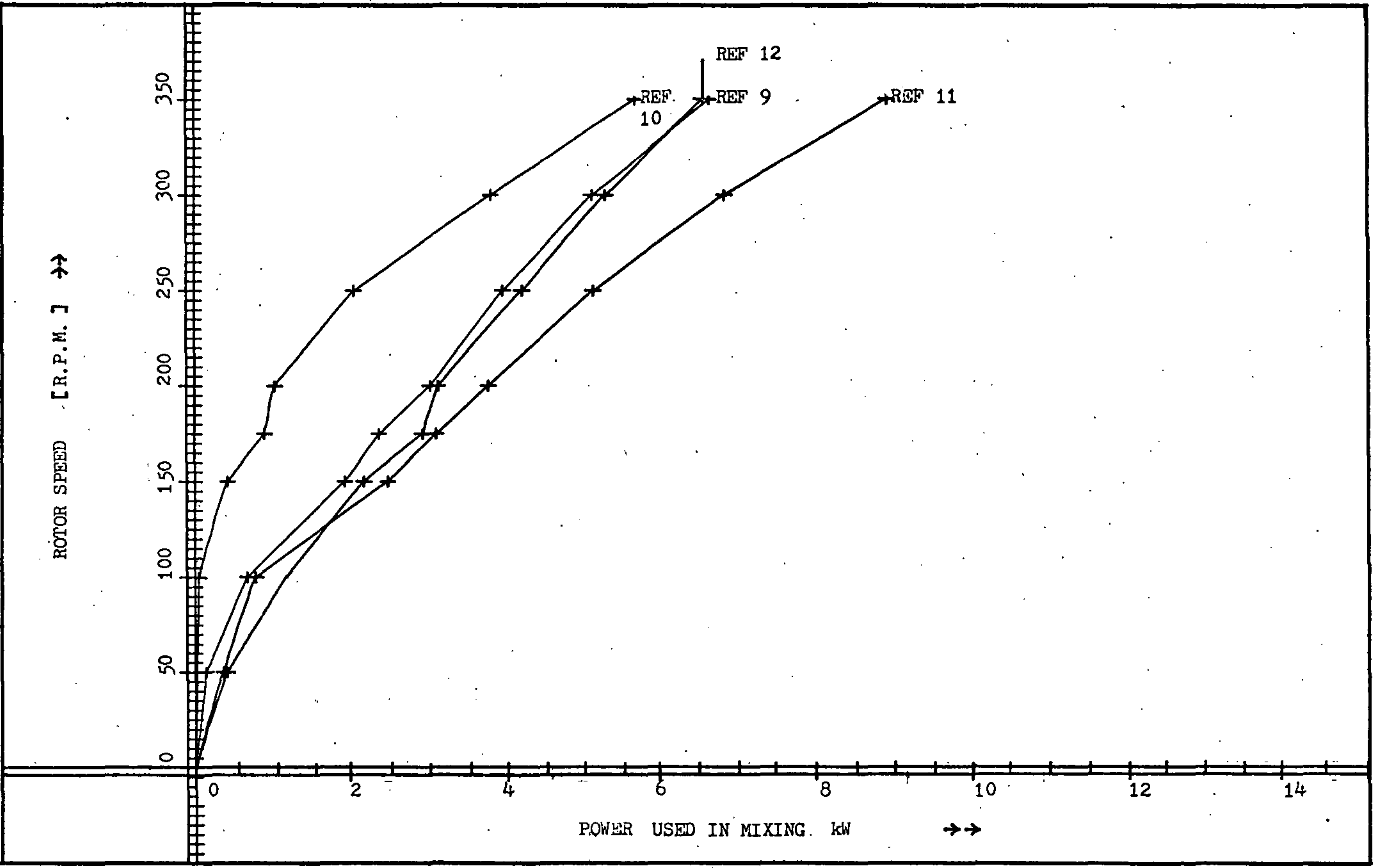


ROTOR SPEED AGAINST POWER USED IN MIXING

PLOT 8.3

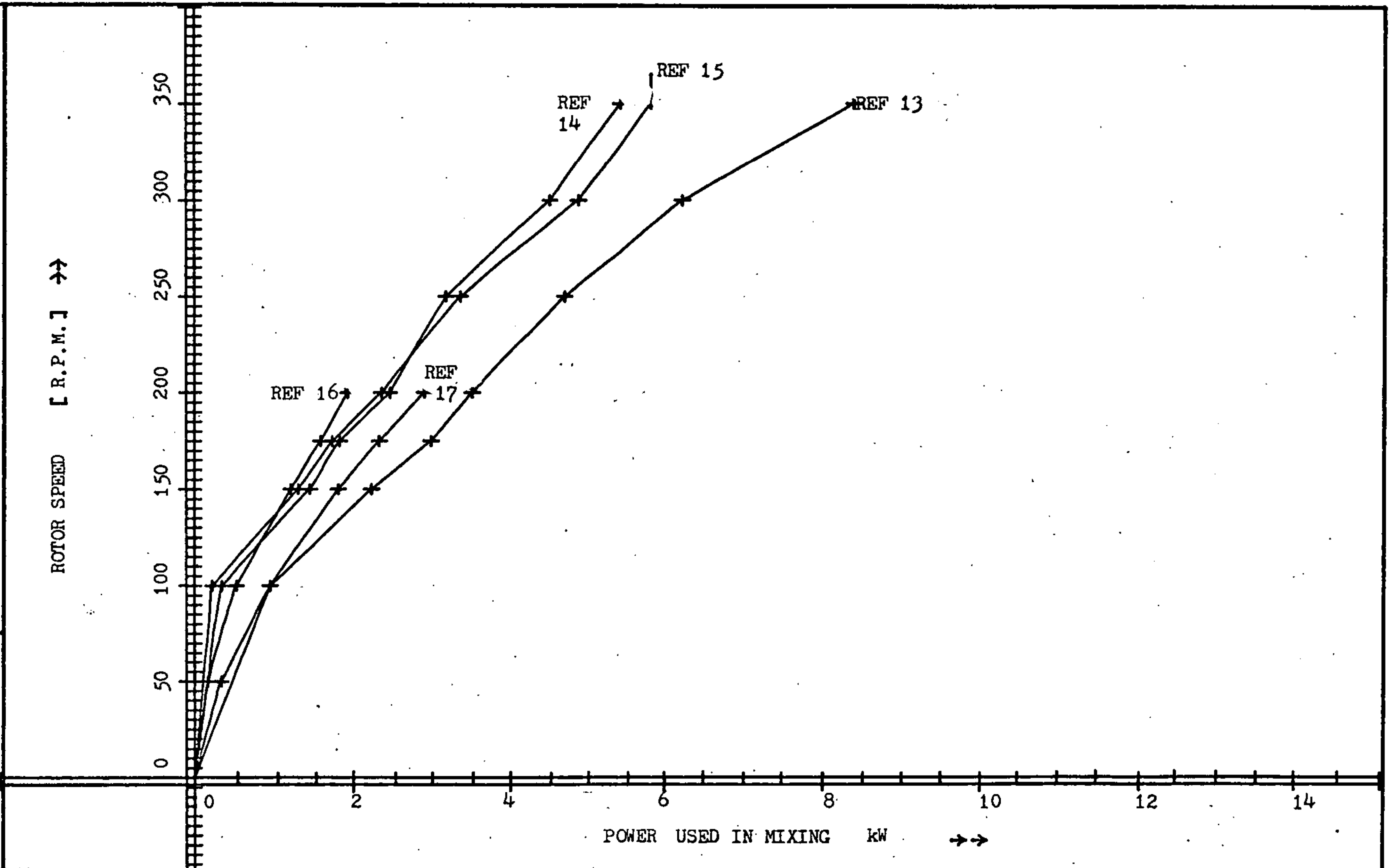
PLOT 8.4

ROTOR SPEED AGAINST POWER USED IN MIXING



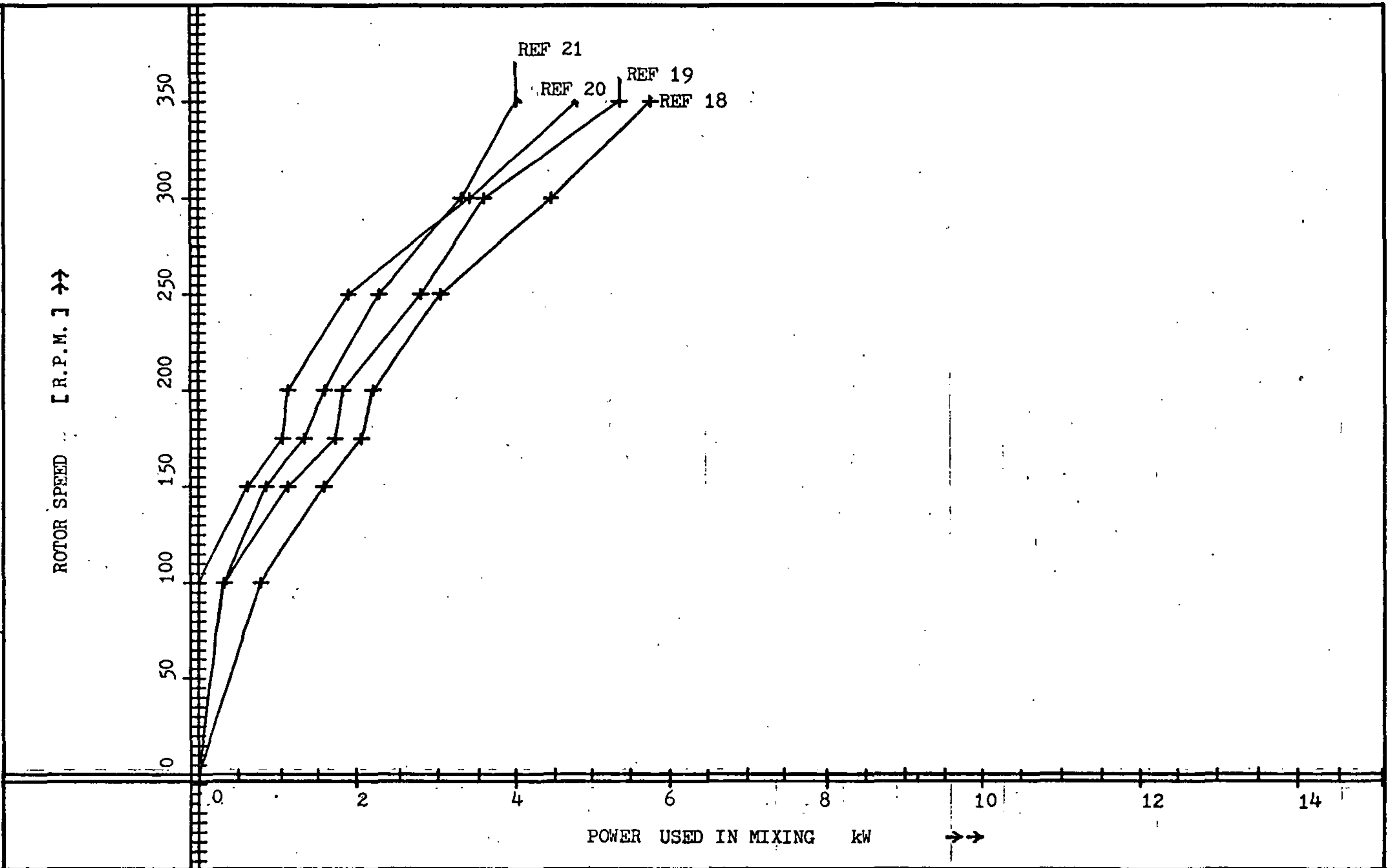
PLOT 8.5

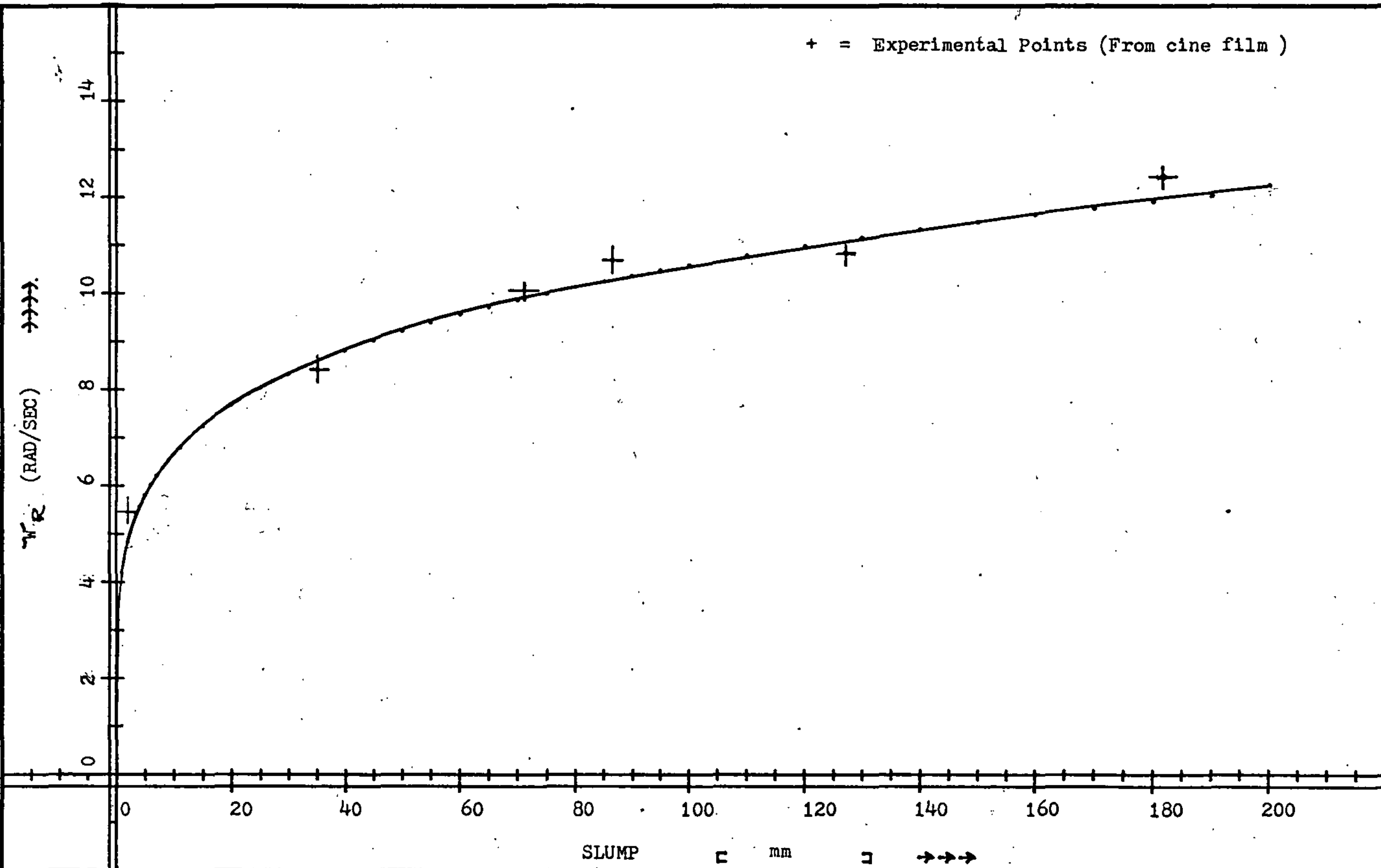
ROTOR SPEED AGAINST POWER USED IN MIXING



PLOT 8.6

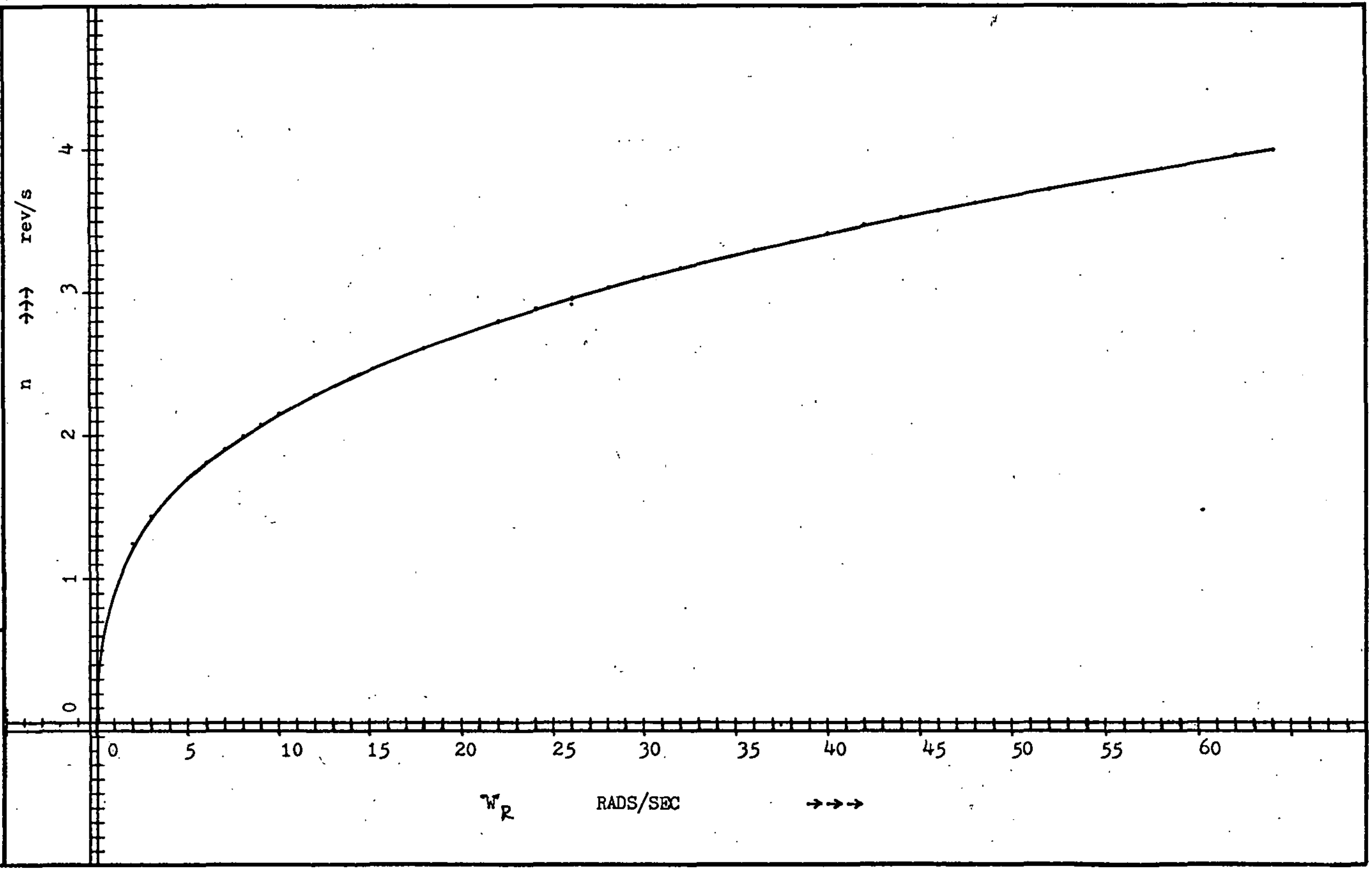
ROTOR SPEED AGAINST POWER USED IN MIXING





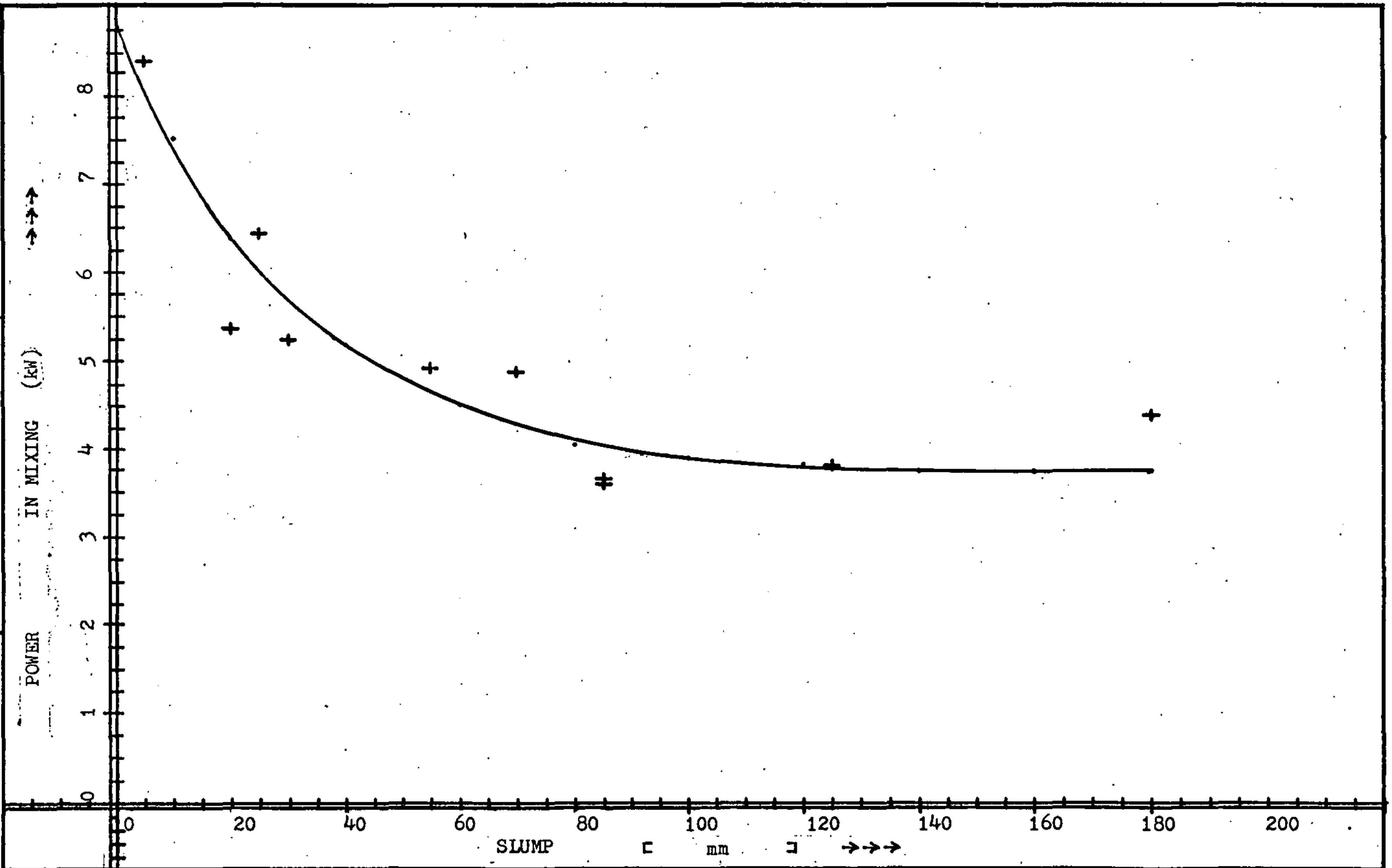
PLOT 8.7

W_R AGAINST SLUMP



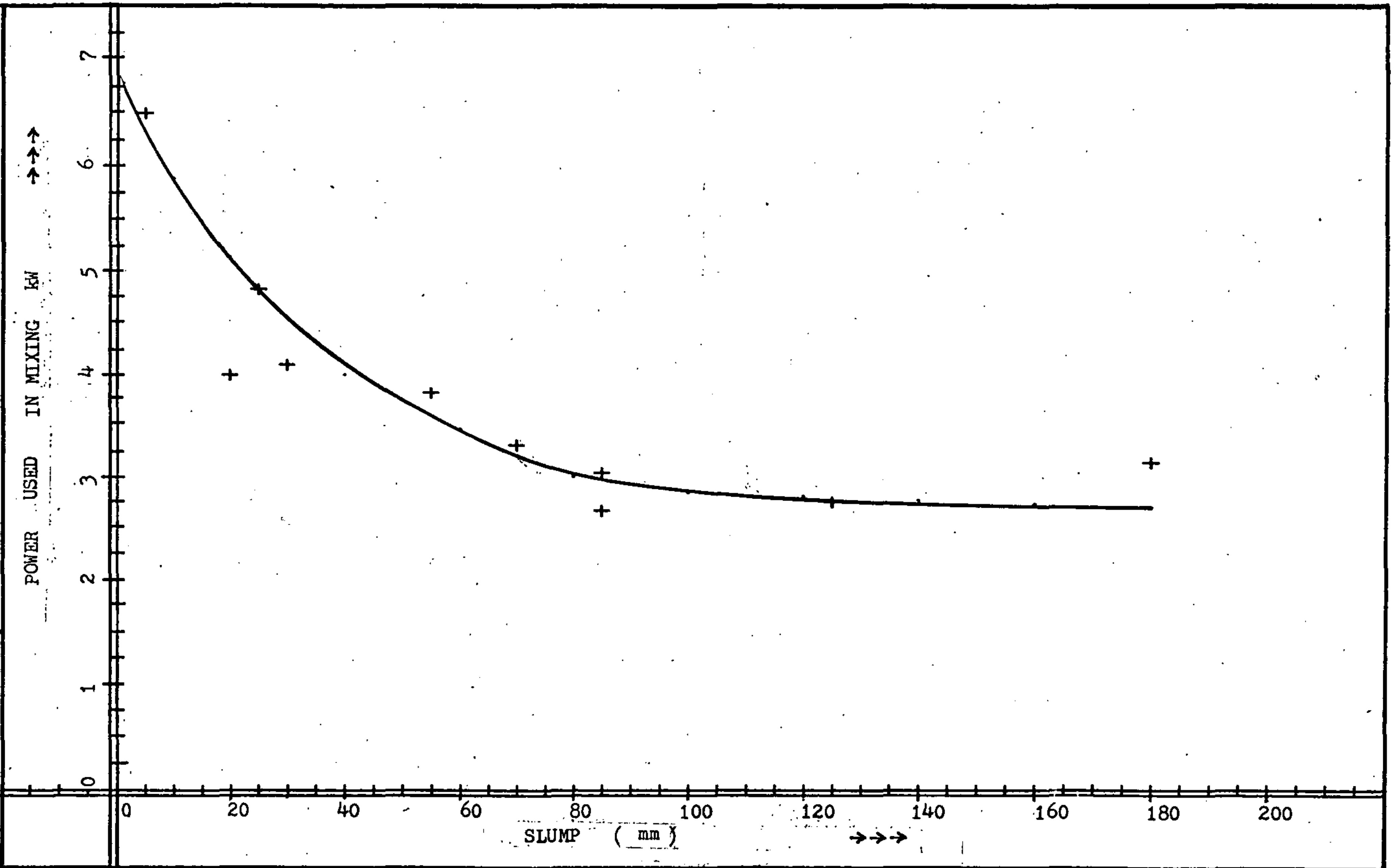
PLOT 8.8

n AGAINST W_R



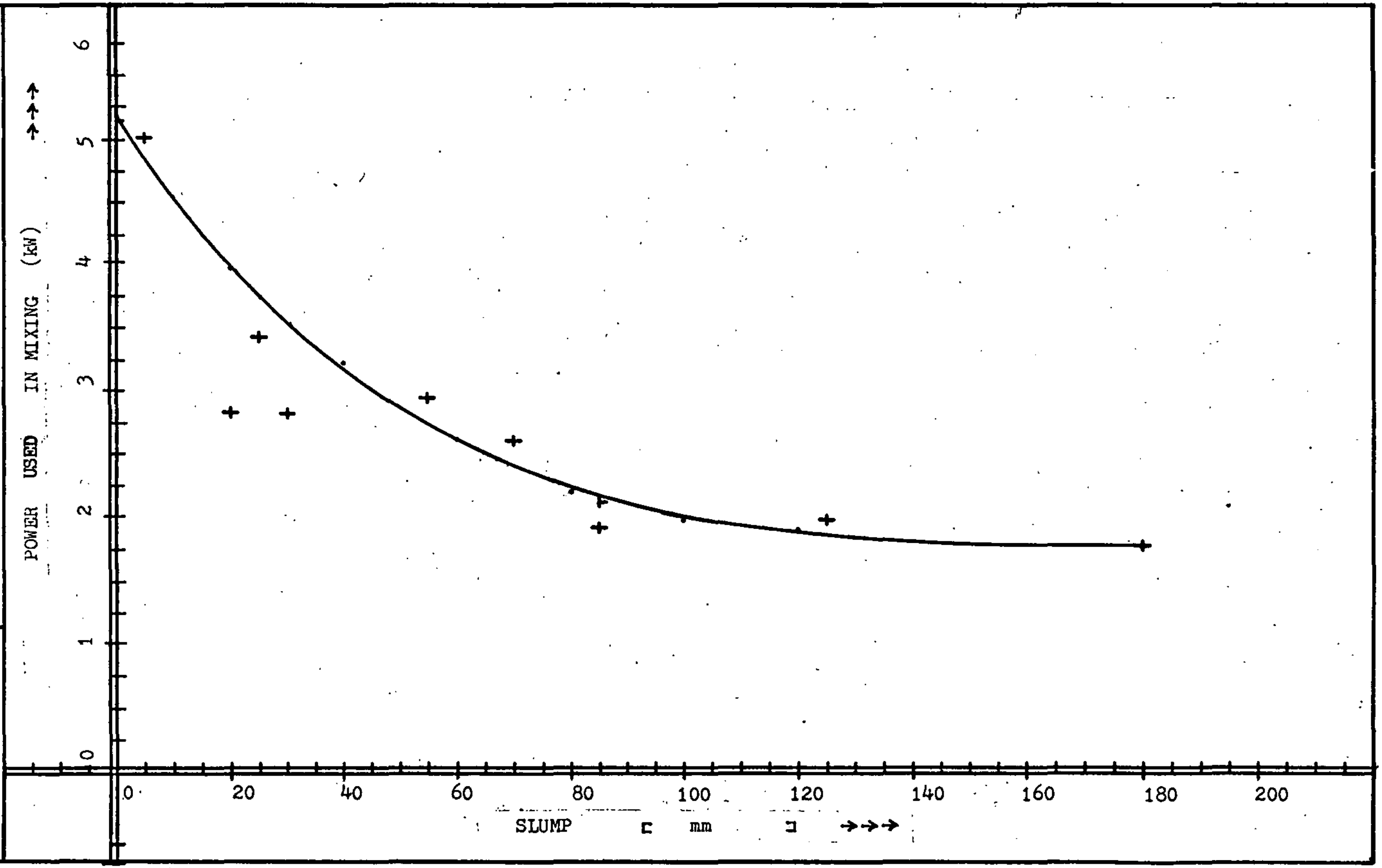
POWER AGAINST SLUMP AT 350 R.P.M.

PLOT 8.9



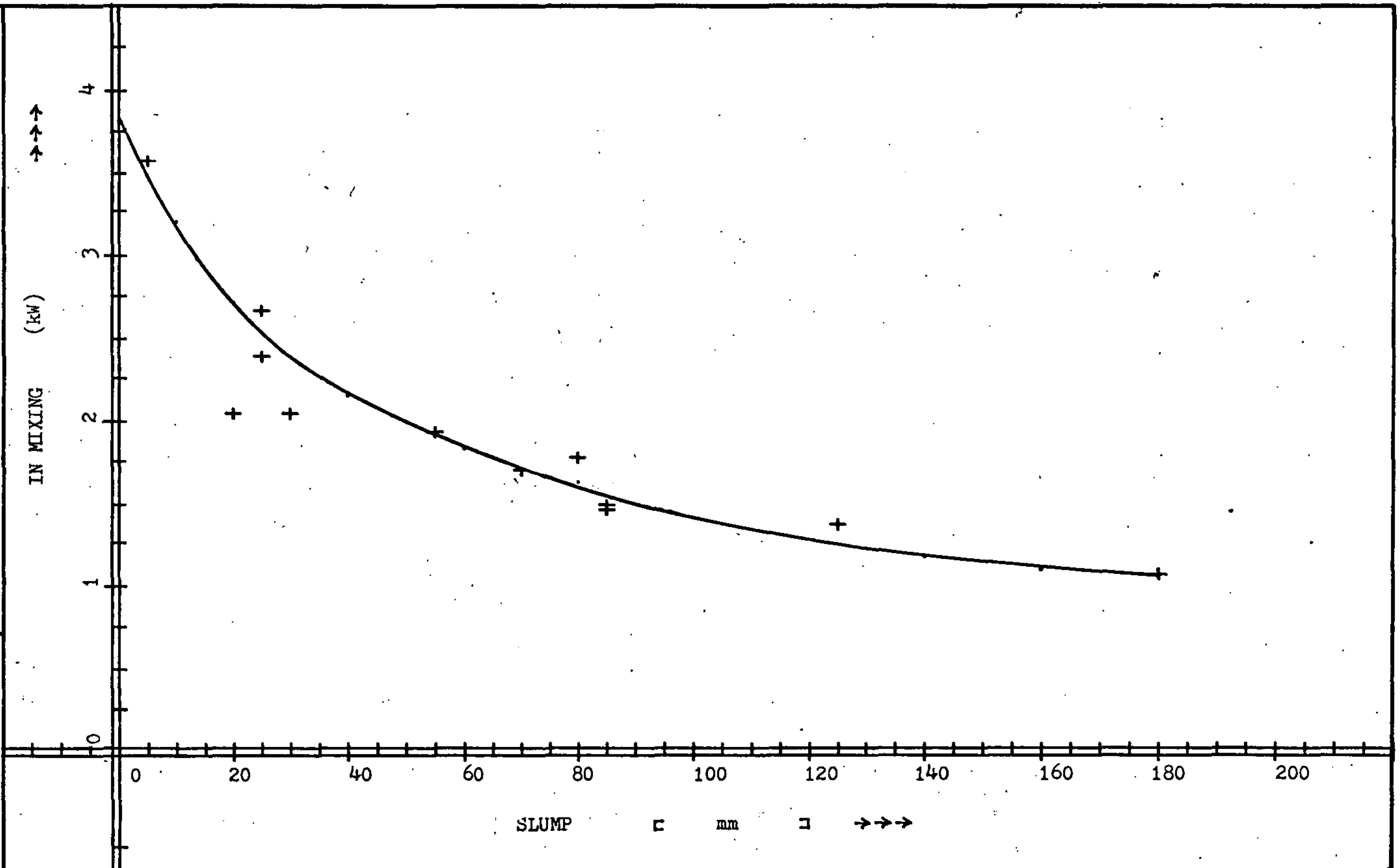
POWER AGAINST SLUMP AT 300 R.P.M.

PLOT 8.10



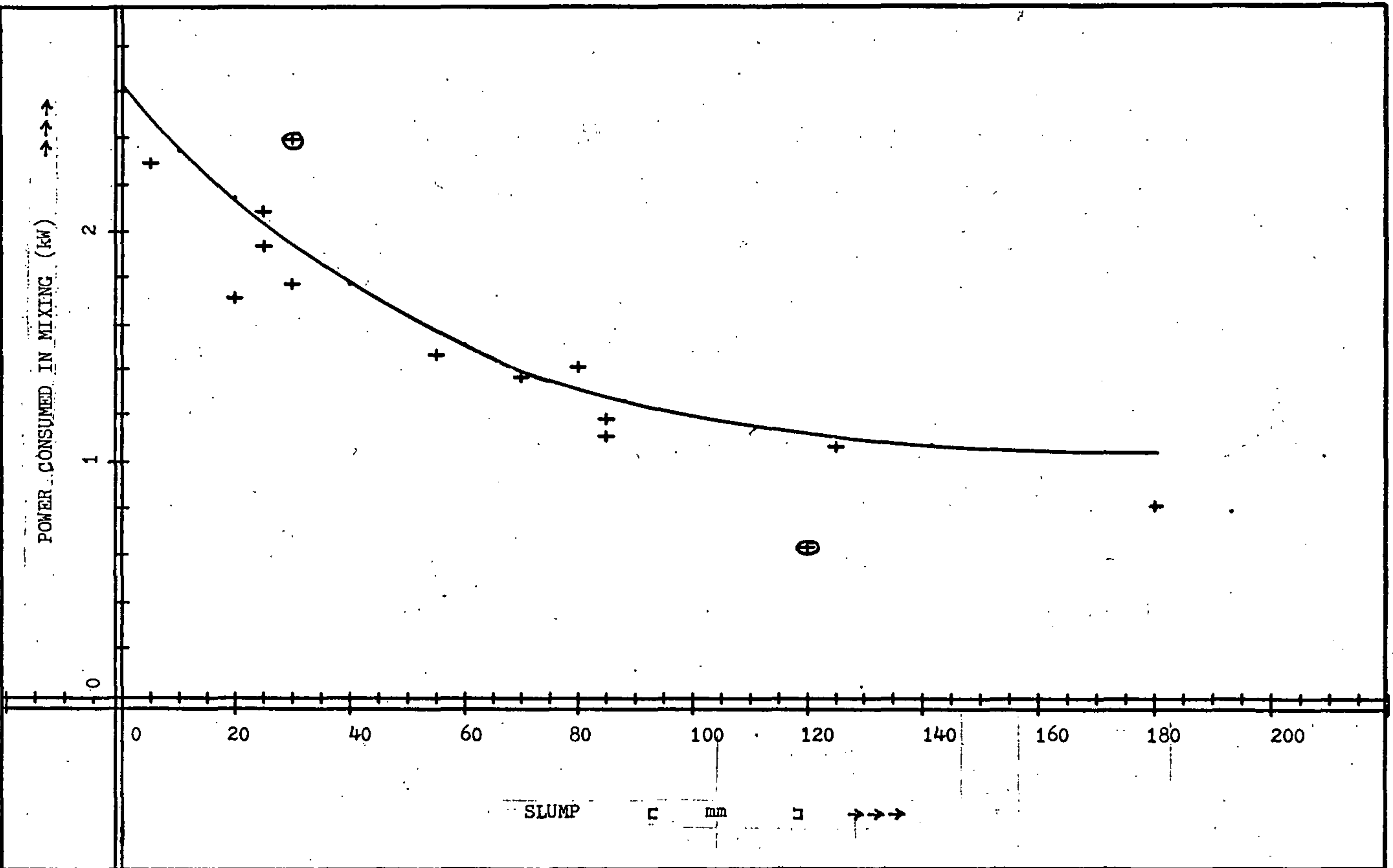
POWER AGAINST SLUMP AT 250 R.P.M.

PLOT 8.11



POWER AGAINST SLUMP AT 200 R.P.M.

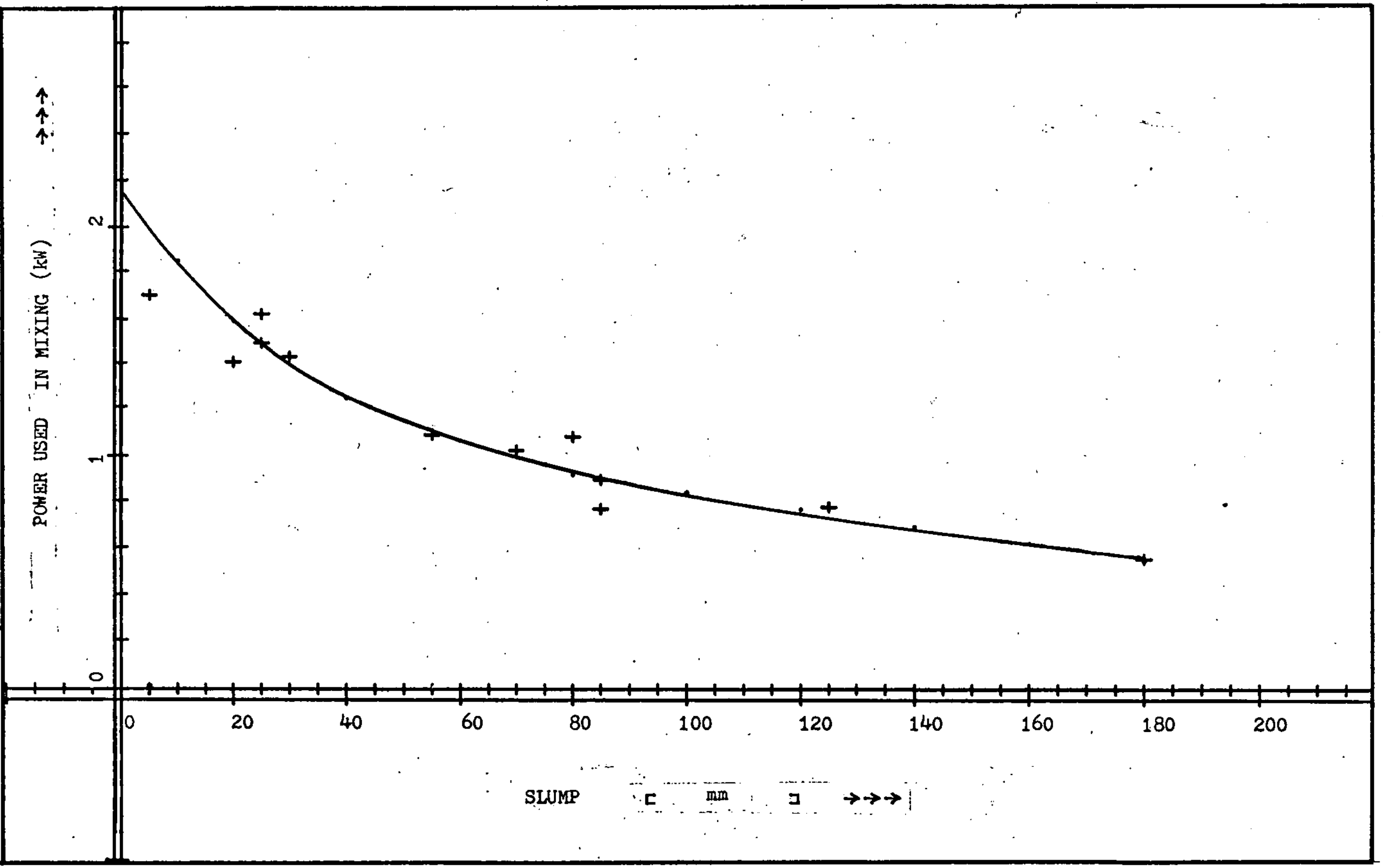
PLOT 8.12



PLOT 8.13

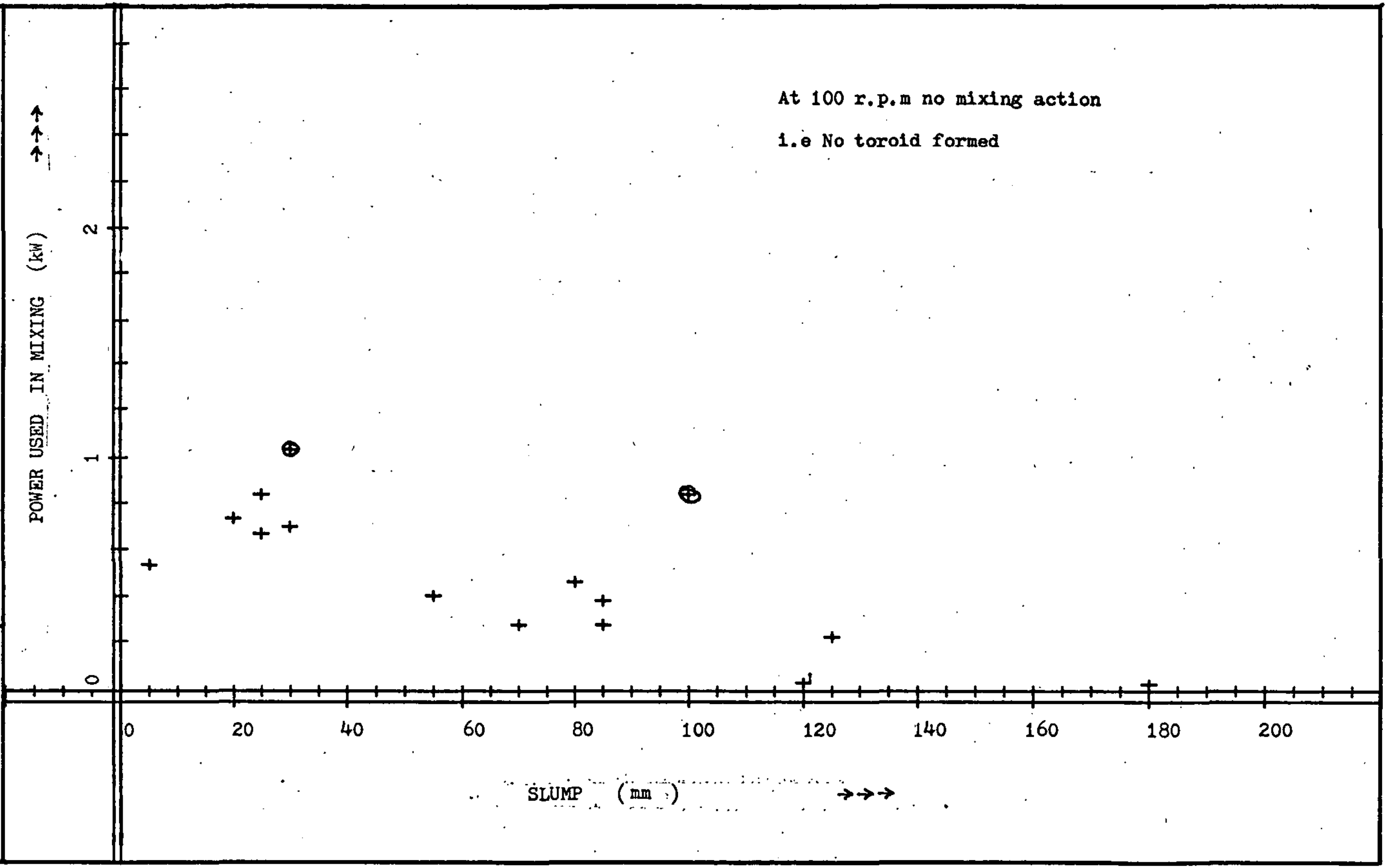
POWER AGAINST SLUMP AT 175 R.P.M. (MOD)

POWER AGAINST SLUMP AT 150 R.P.M.



PLOT 8.14

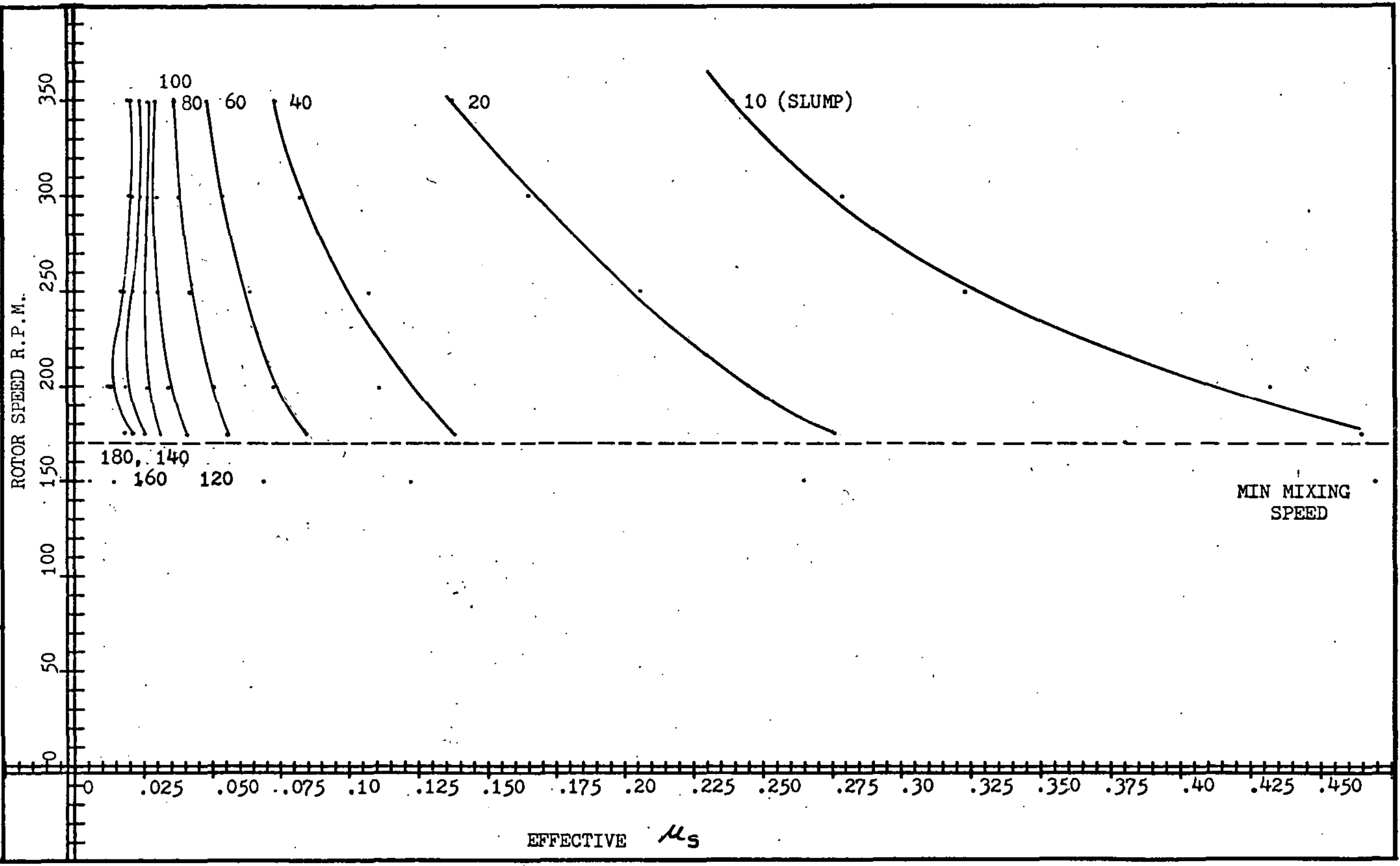
POWER AGAINST SLUMP AT 100 R.P.M.



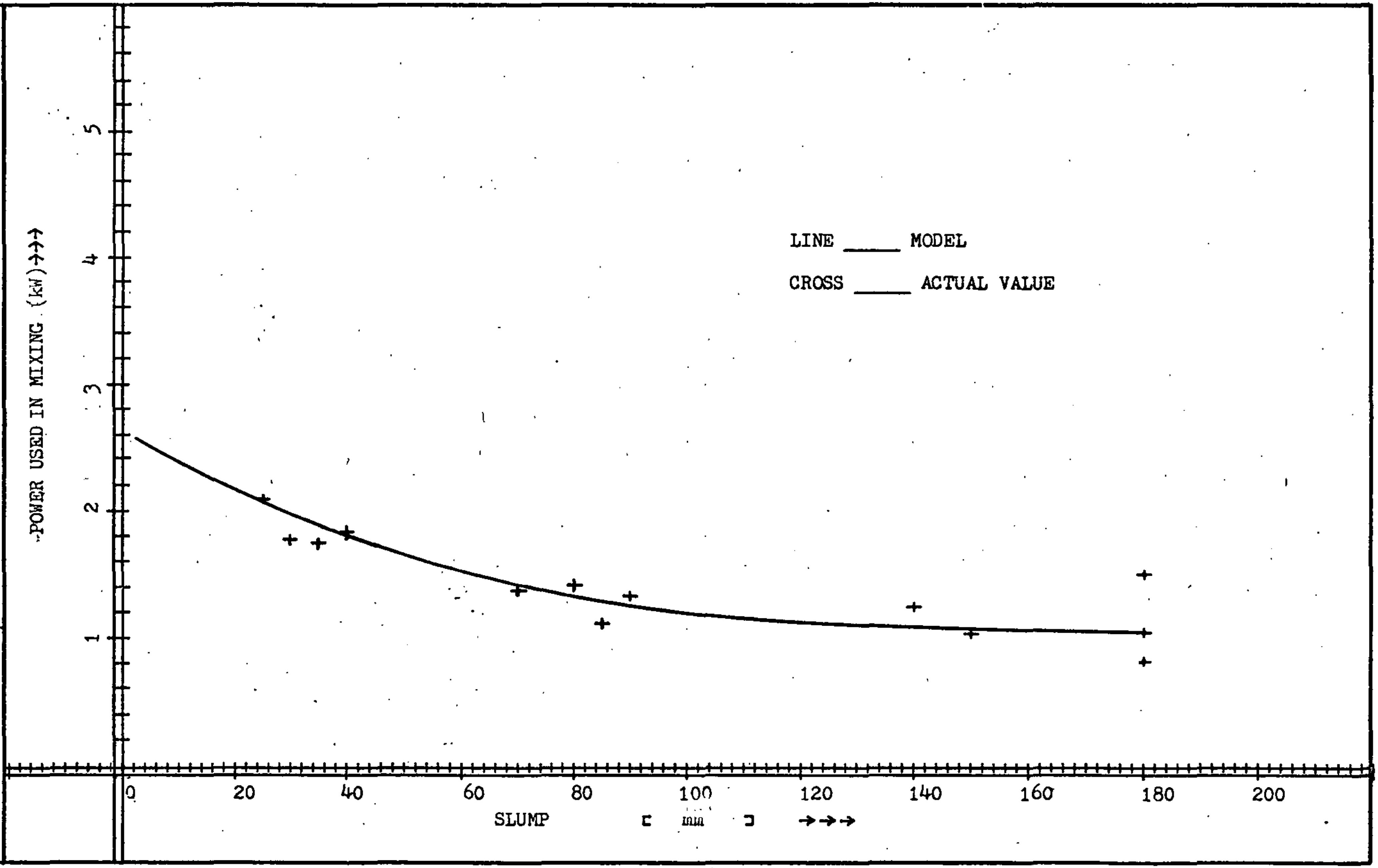
PLOT 8.15

PLOT 8.16

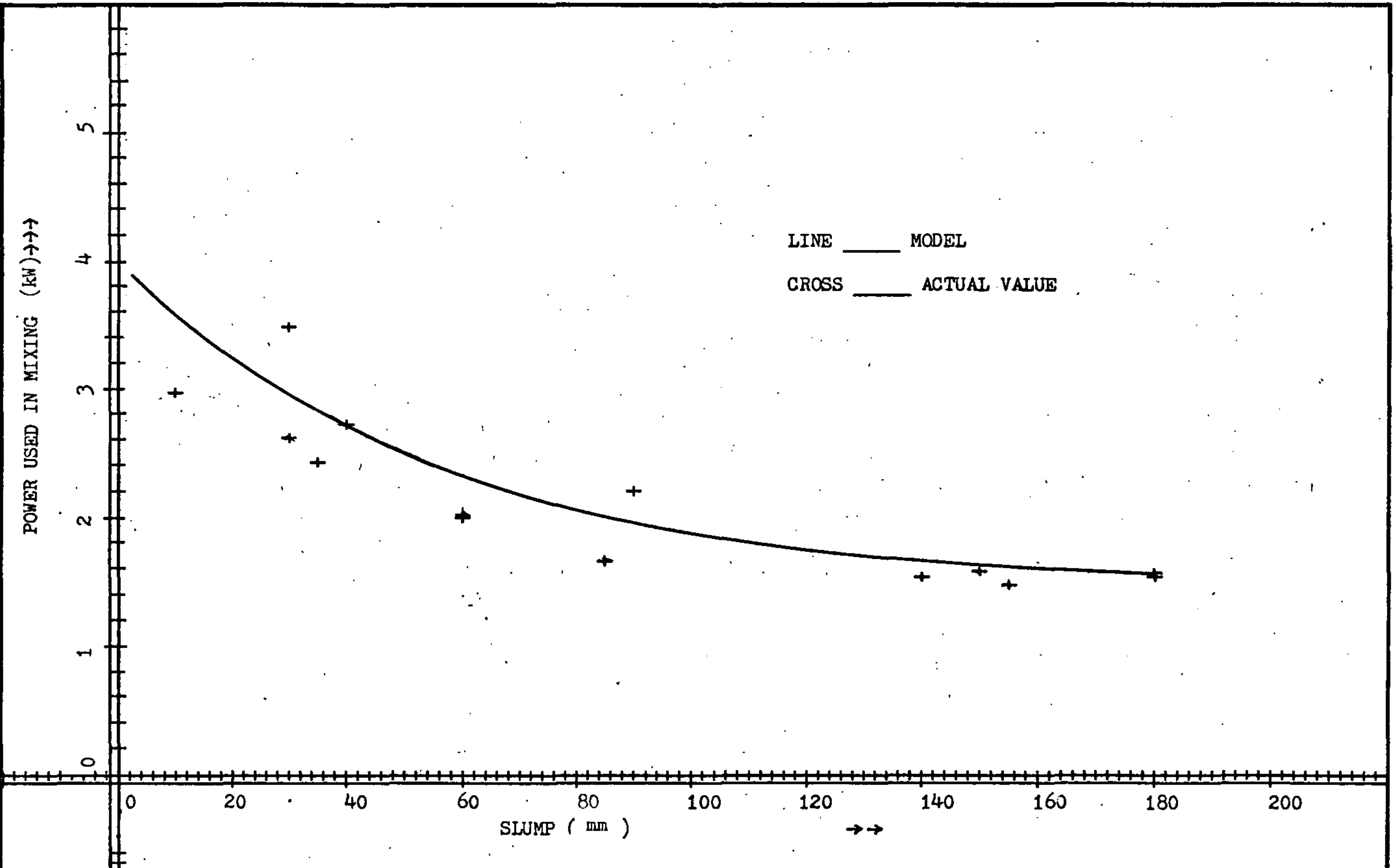
PLOT OF ROTOR SPEED AGAINST μ_s



POWER AGAINST SLUMP AT 175 R.P.M. (91 kg)

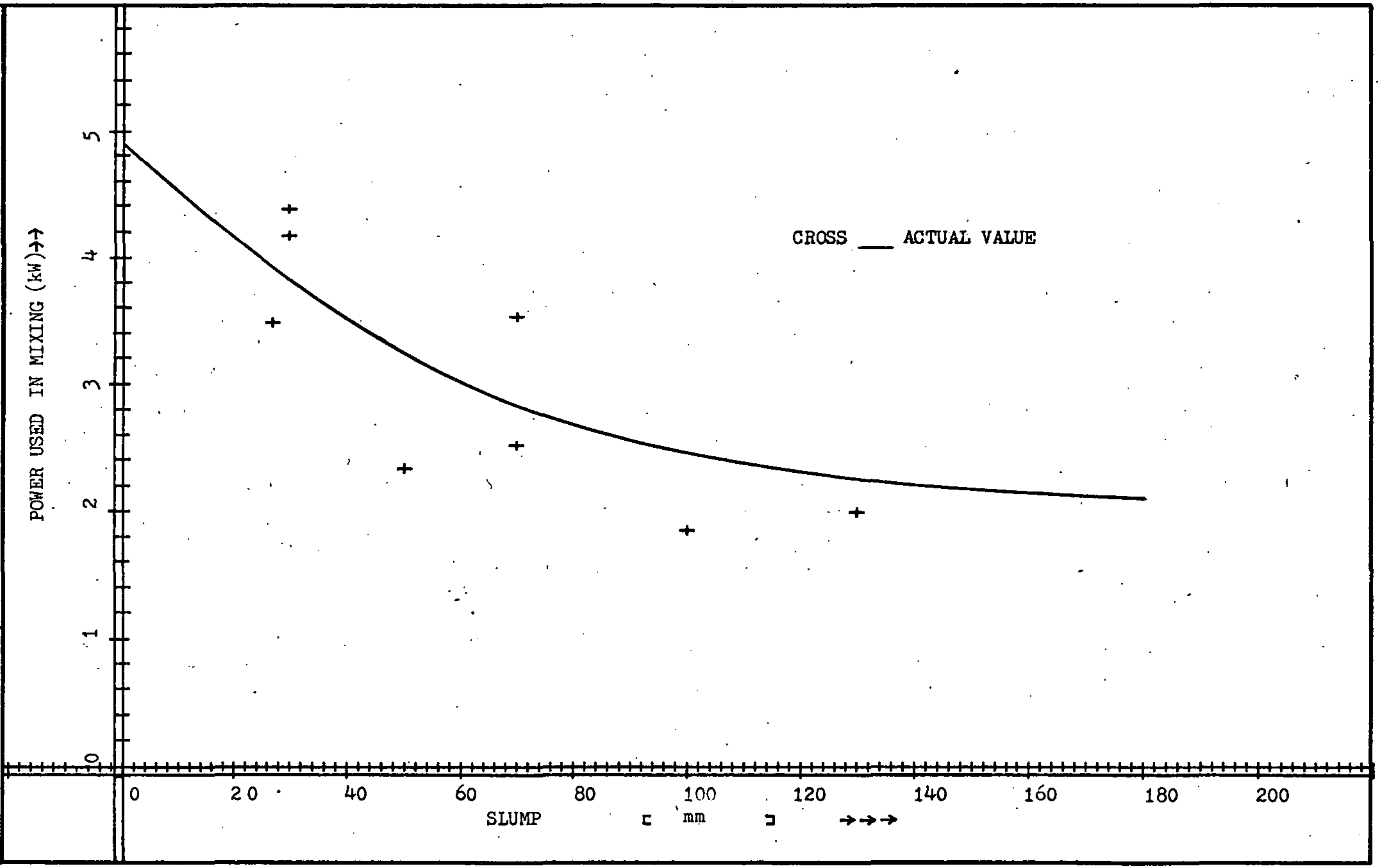


PLOT 8.17



POWER AGAINST SLUMP AT 175 R.P.M. (136 kg)

PLOT 8.18

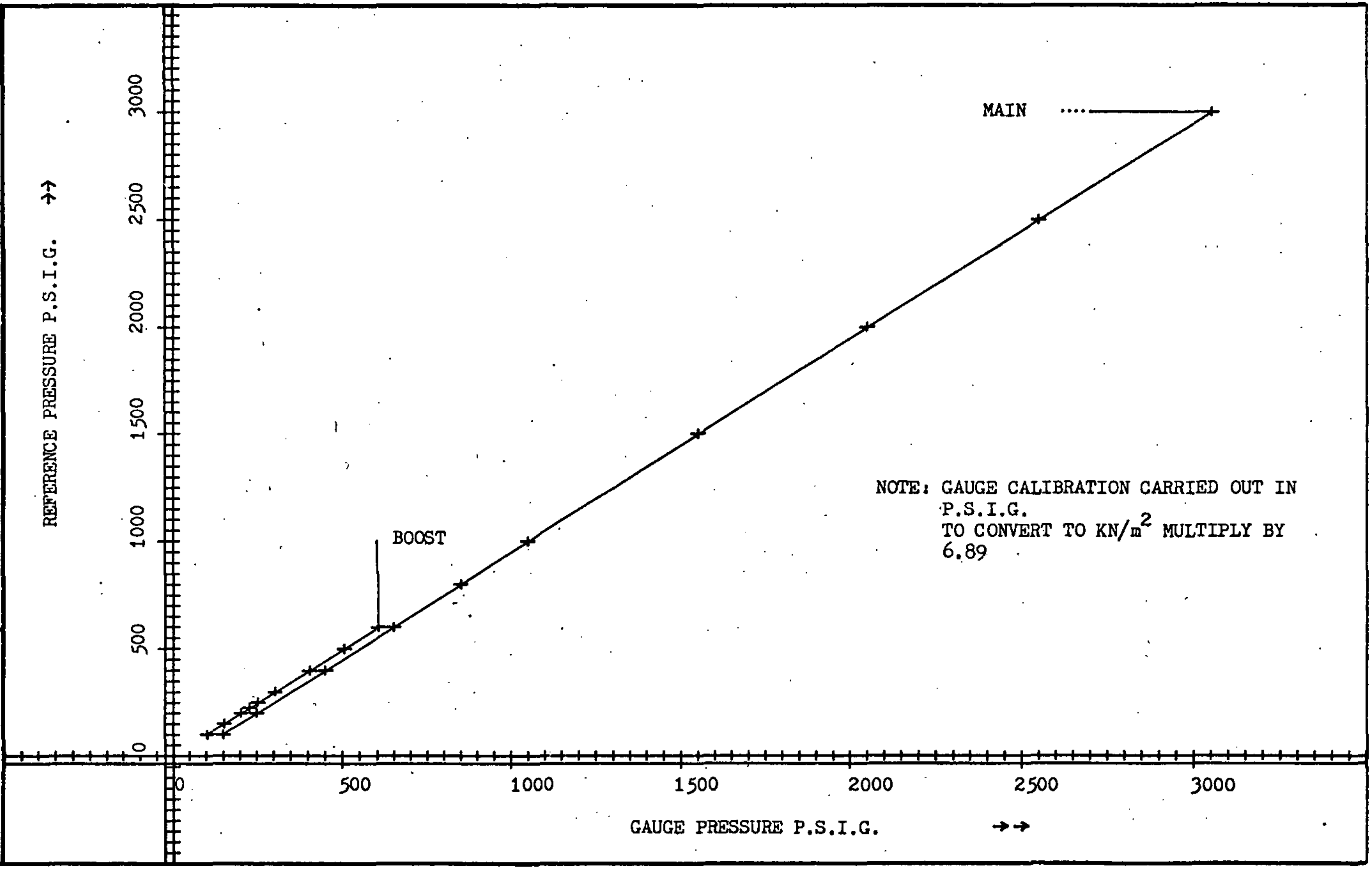


POWER AGAINST SLUMP AT 175 R.P.M. (181 kg)

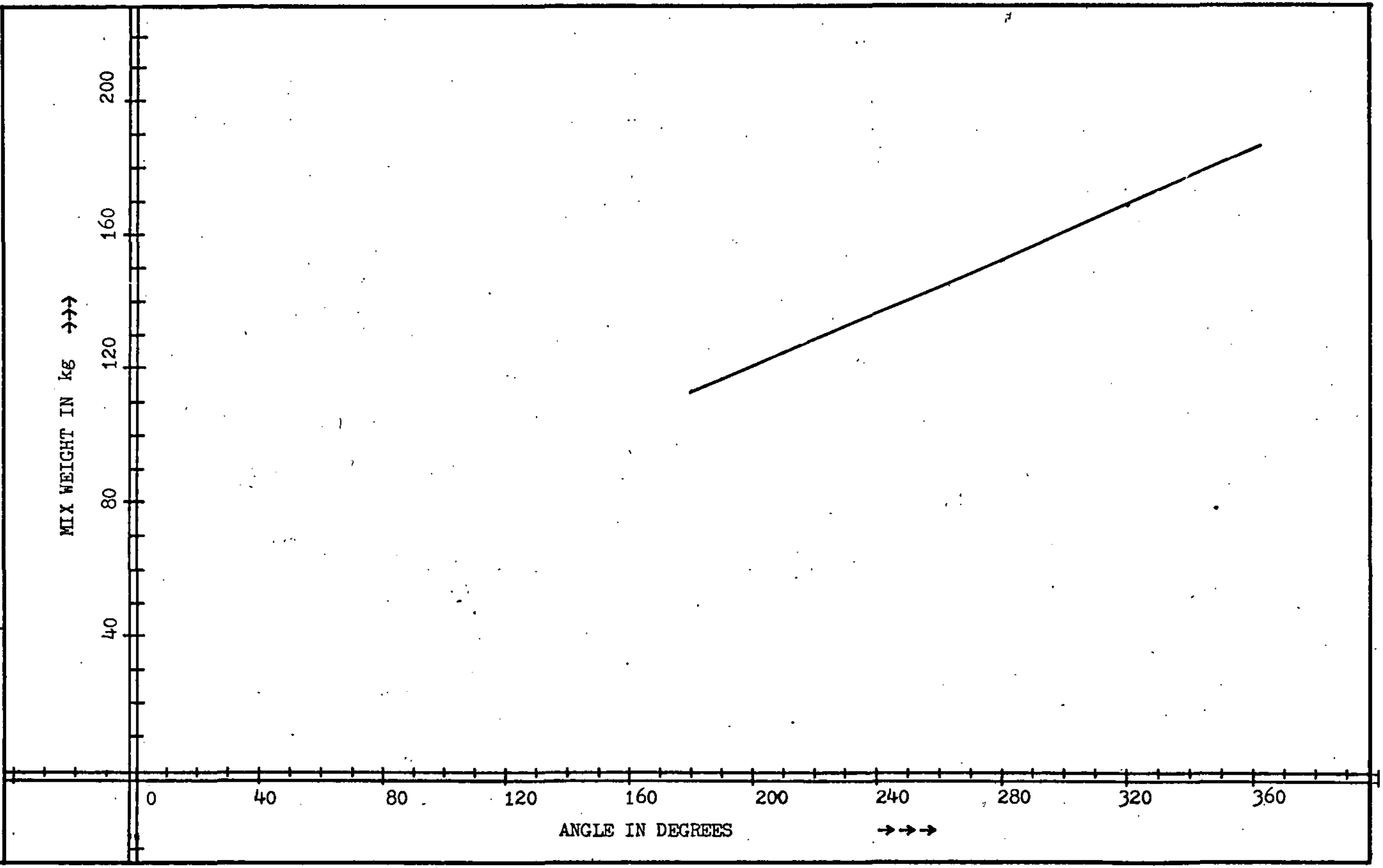
PLOT 8.19

GAUGE CALIBRATION POWER PACK

PLOT 8.20



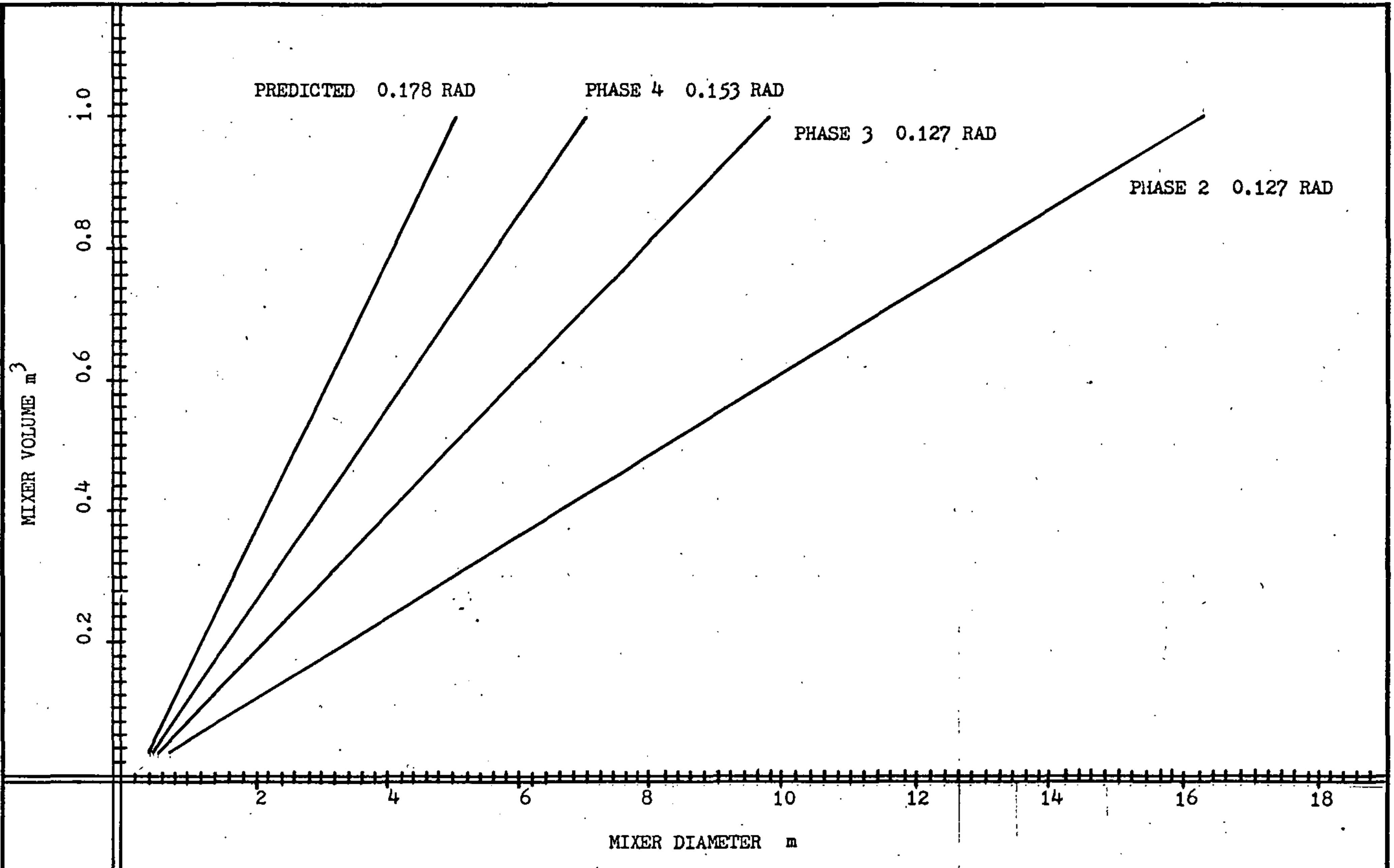
MIX WEIGHT AGAINST STATOR ANGLE



PLOT 8.21

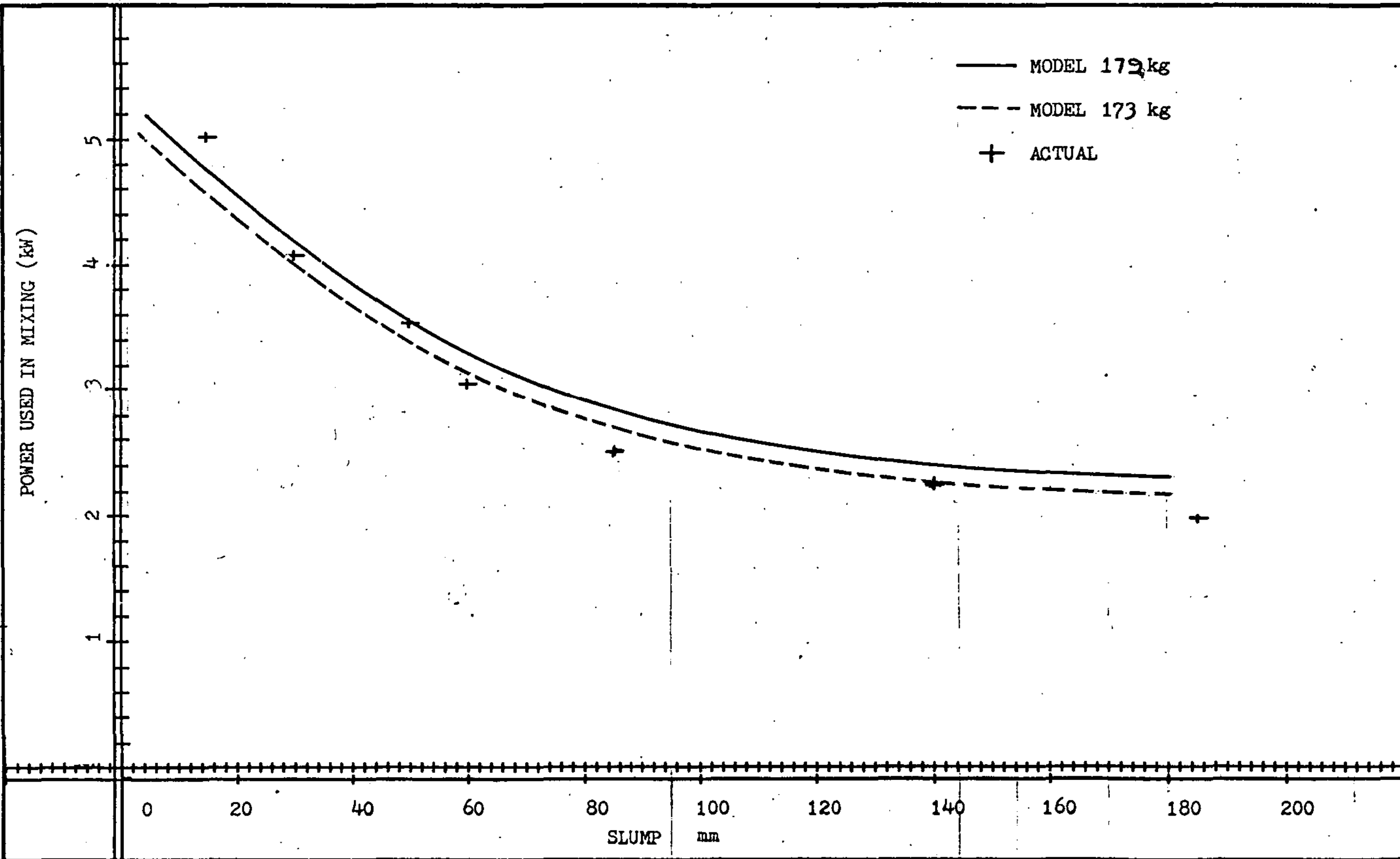
PLOT 8.22

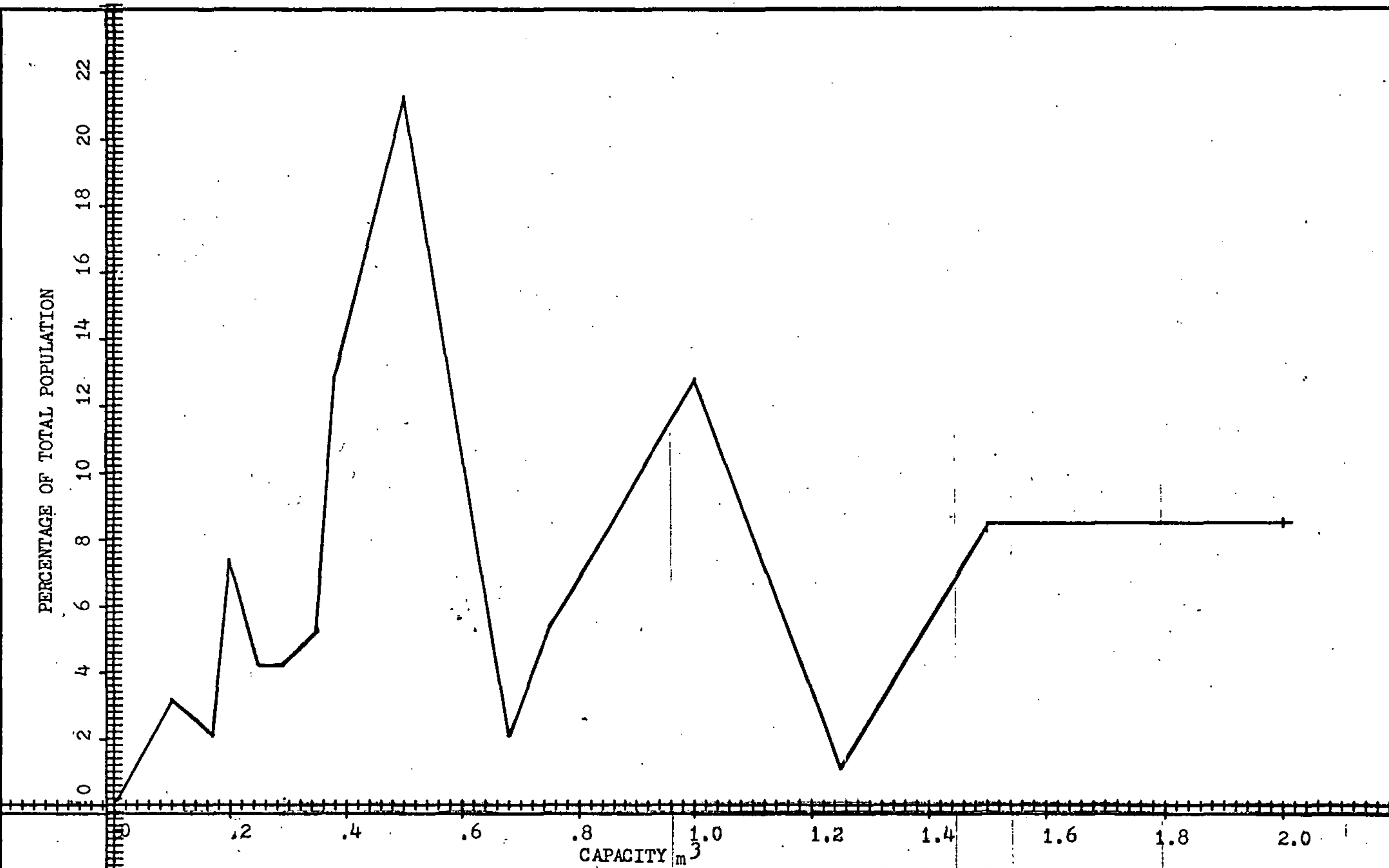
MIXER VOLUME AGAINST MIXER DIAMETER



PLOT 8.23

POWER CONSUMED IN MIXING V SLUMP



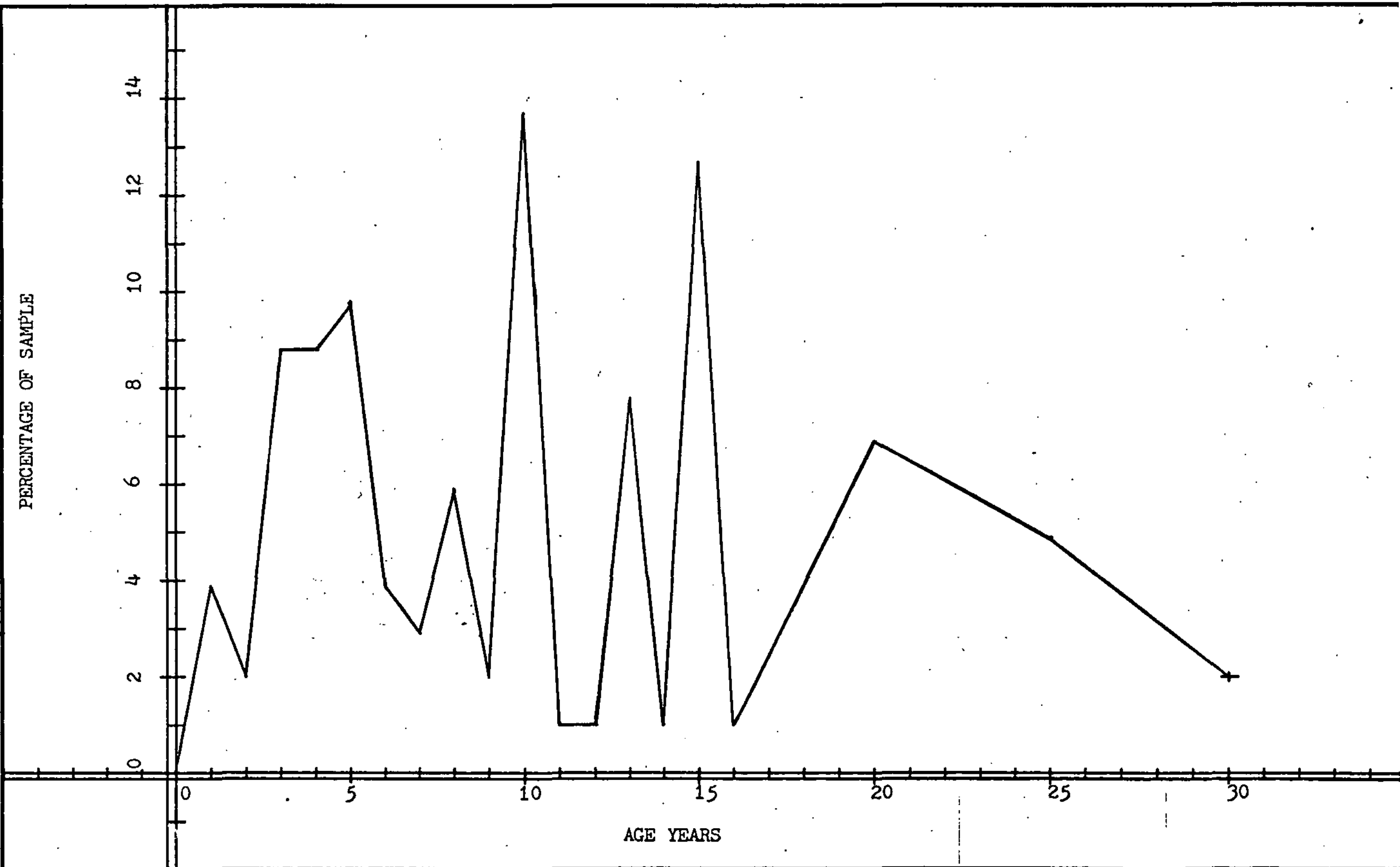


PLOT 9.1

% OF TOTAL AGAINST CAPACITY M3

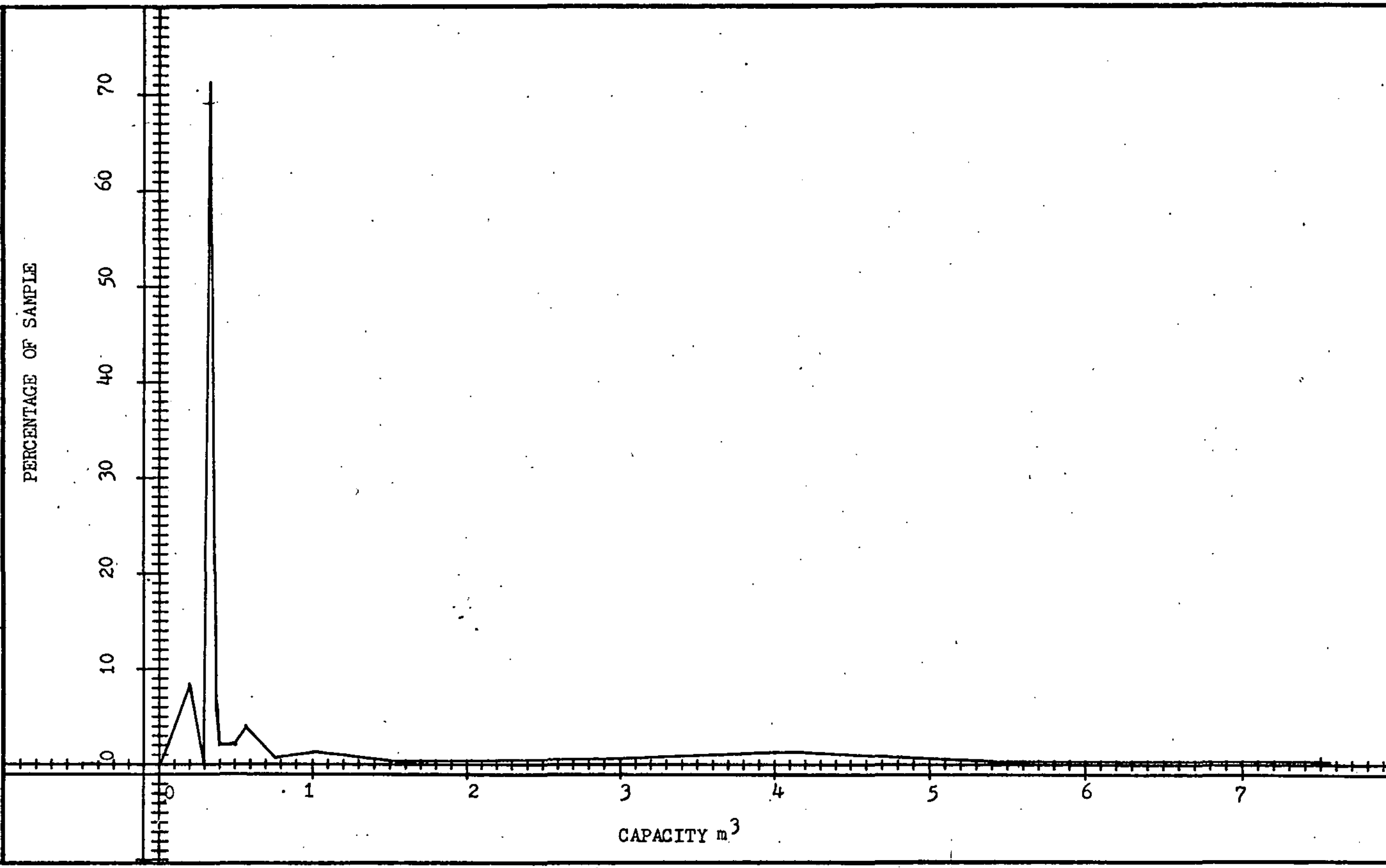
PLOT 9.2

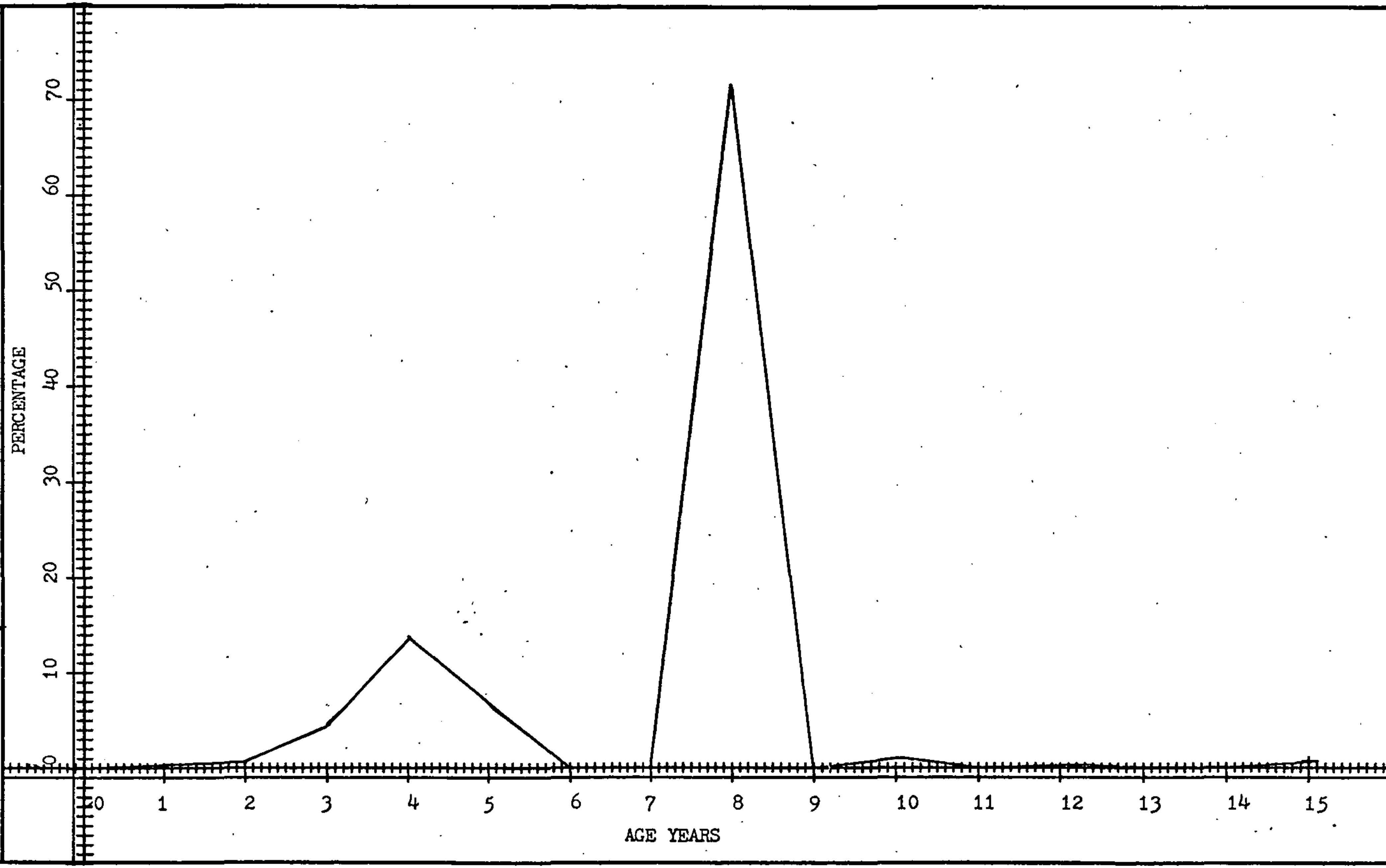
PERCENTAGE OF SAMPLE AGAINST AGE YEARS



PLOT 9.3

PERCENTAGE OF SAMPLE AGAINST CAPACITY



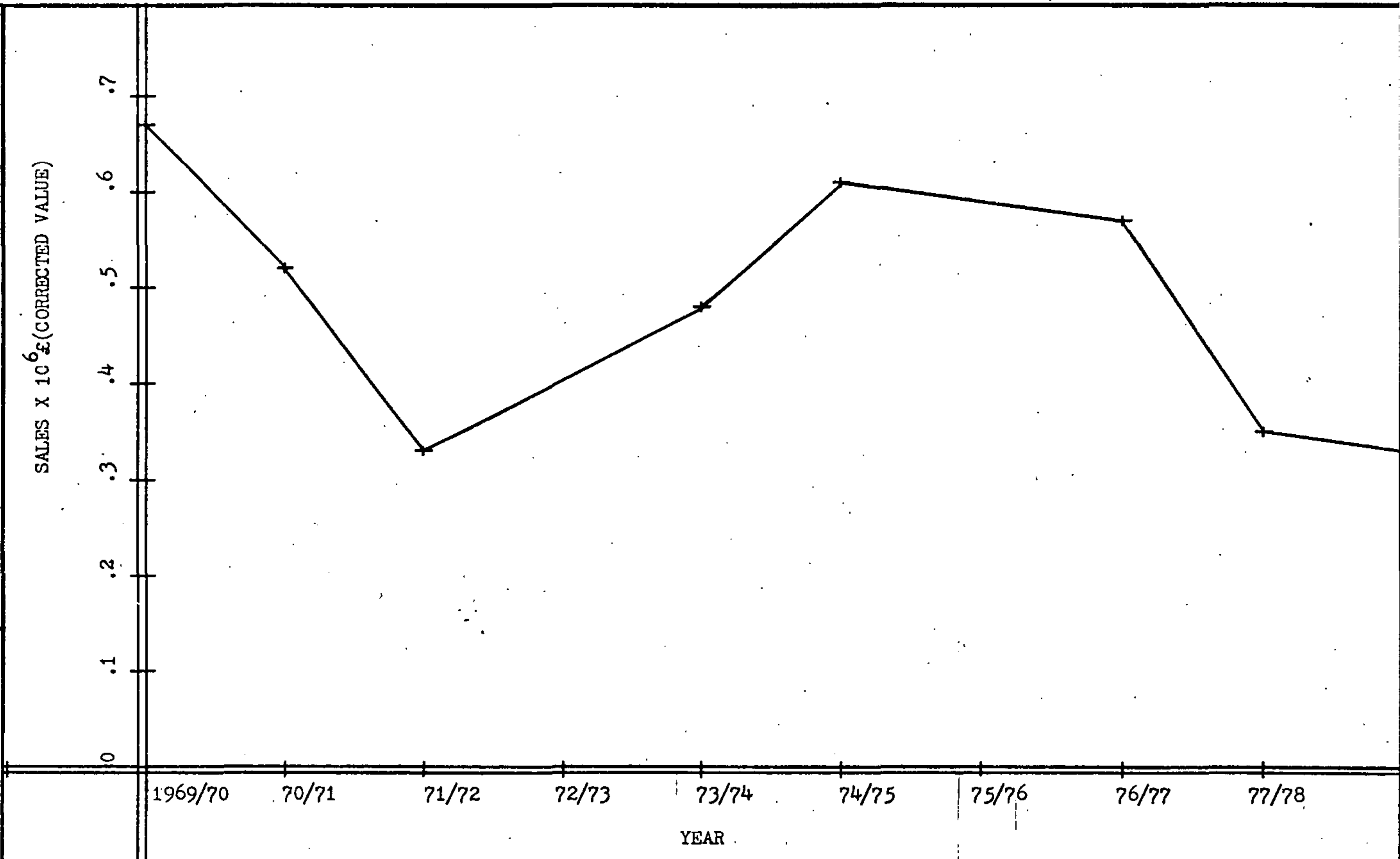


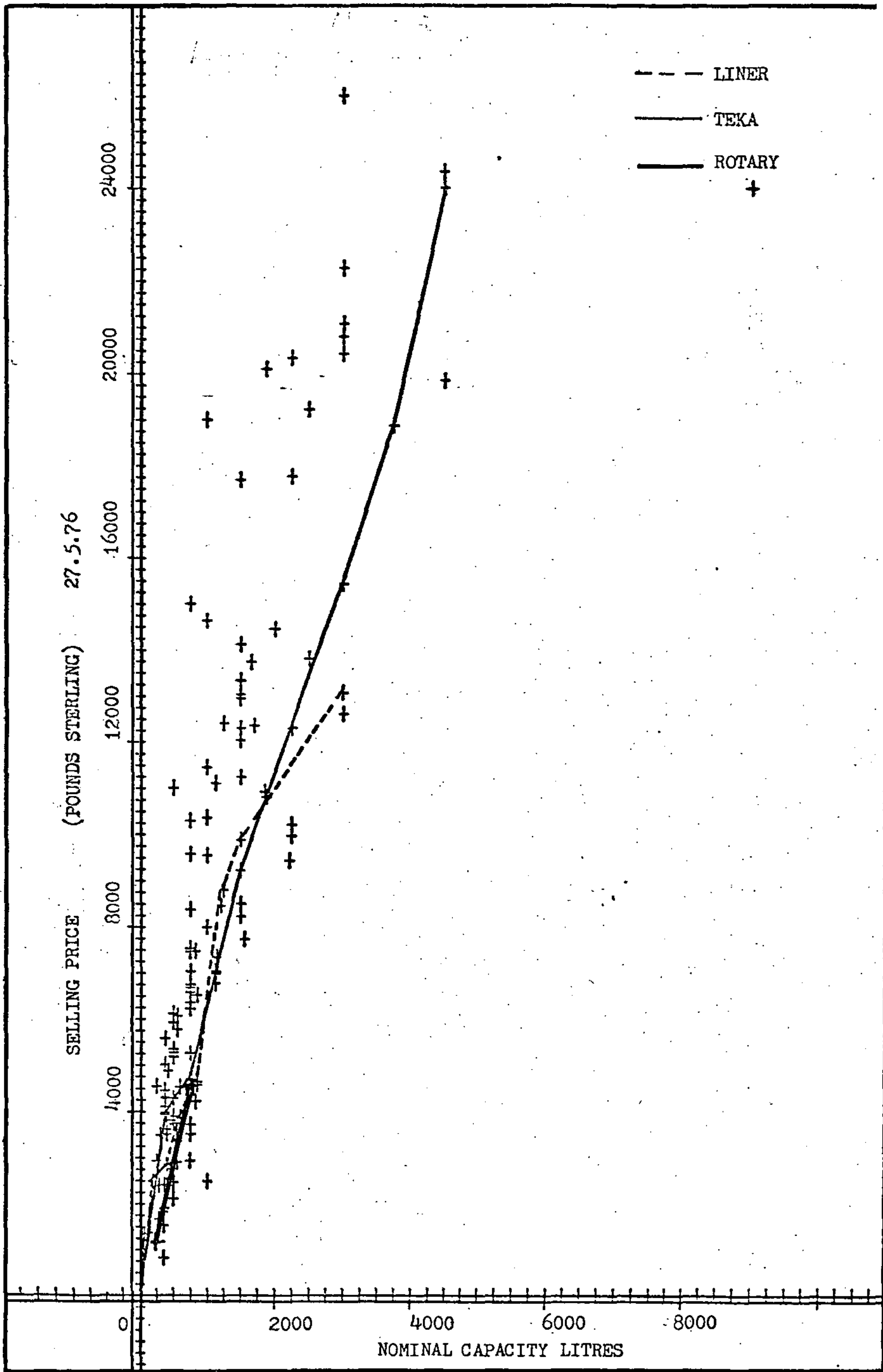
PERCENTAGE OF SAMPLE AGAINST AGE

PLOT 9.4

PLOT 9.5

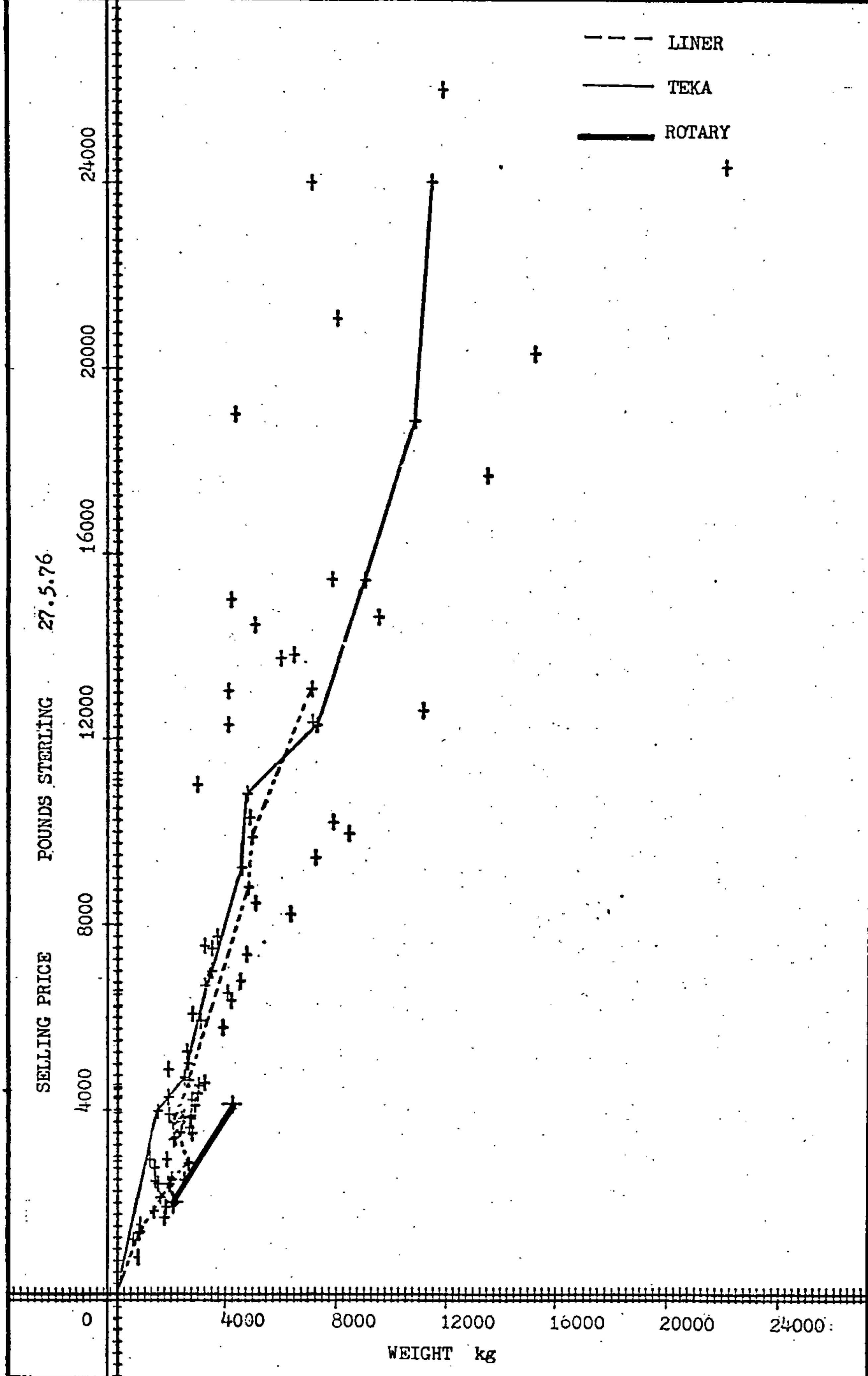
SALES AGAINST YEAR





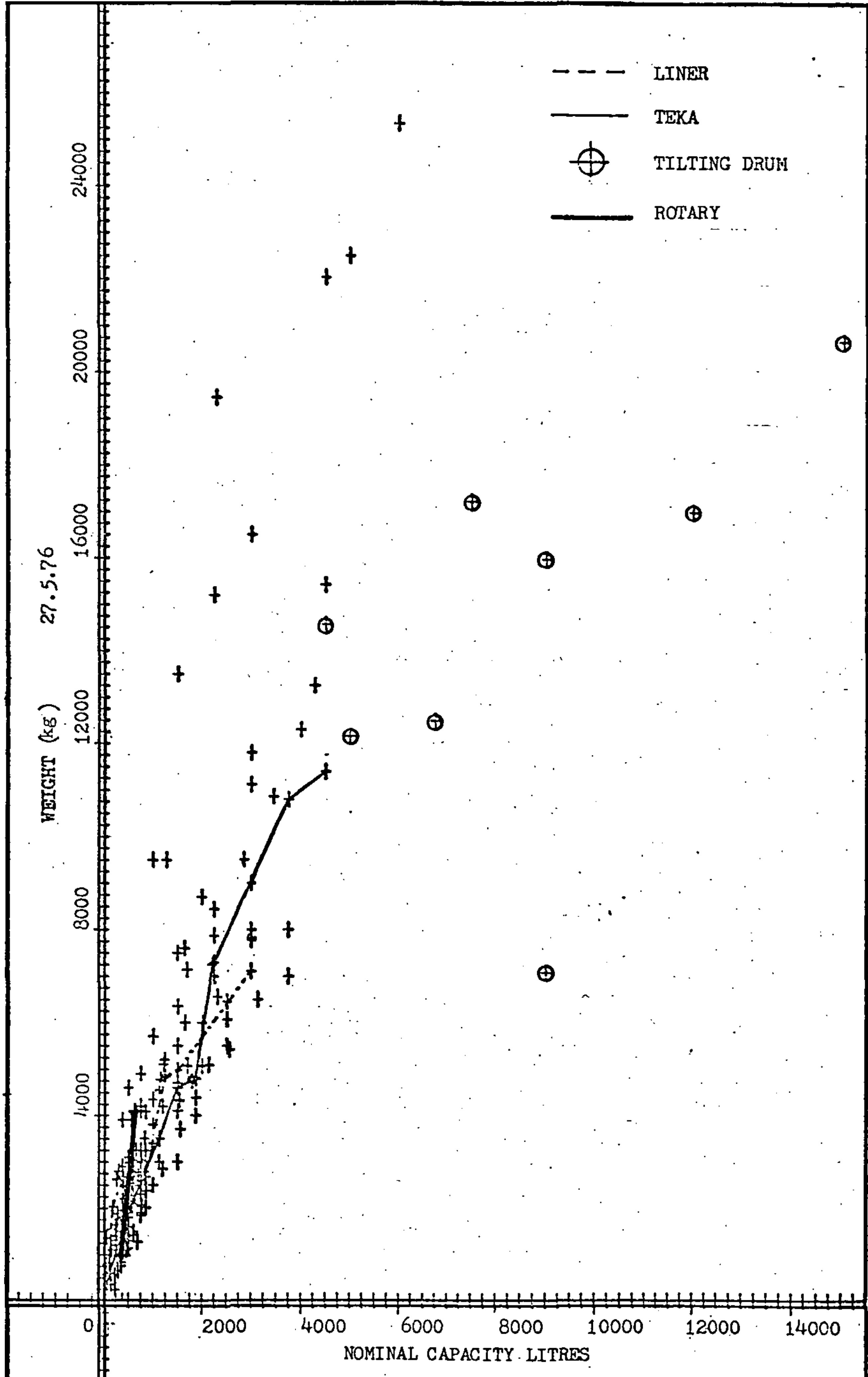
SELLING PRICE AGAINST NOMINAL CAPACITY

Plot 14.1



SELLING PRICE AGAINST WEIGHT

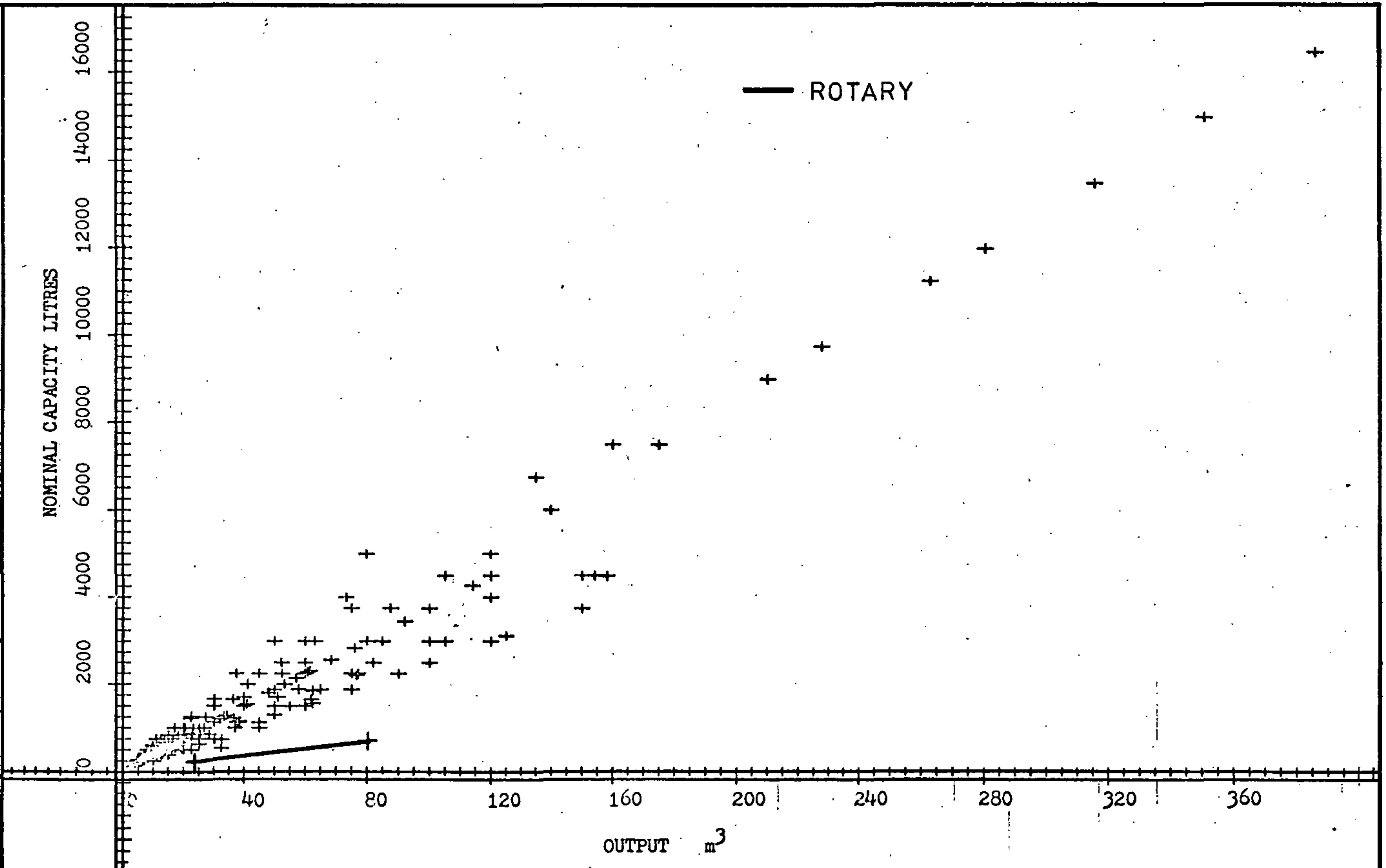
Plot 14.2



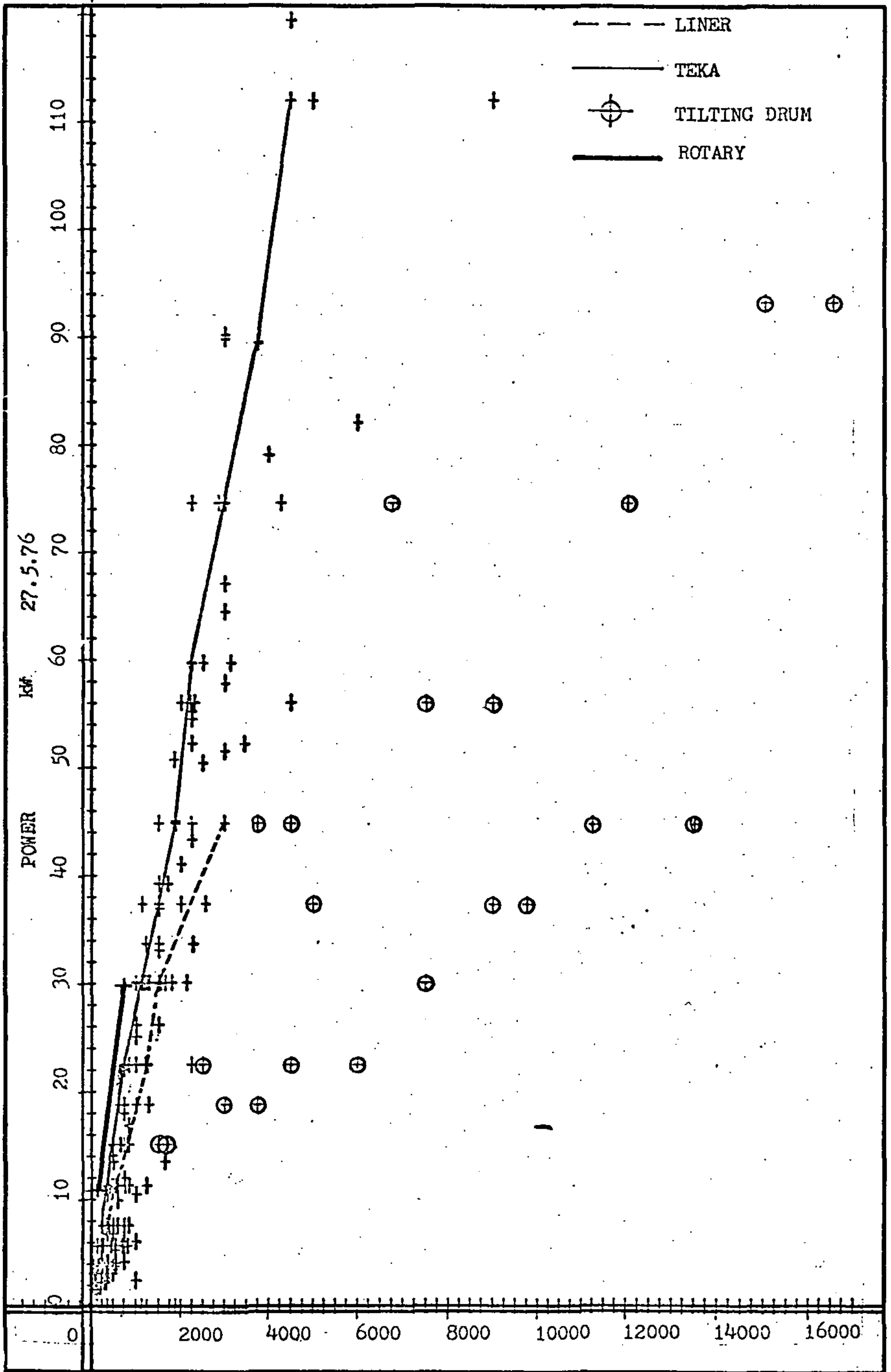
WEIGHT AGAINST NOMINAL CAPACITY

Plot 14.3

NOMINAL CAPACITY AGAINST OUTPUT

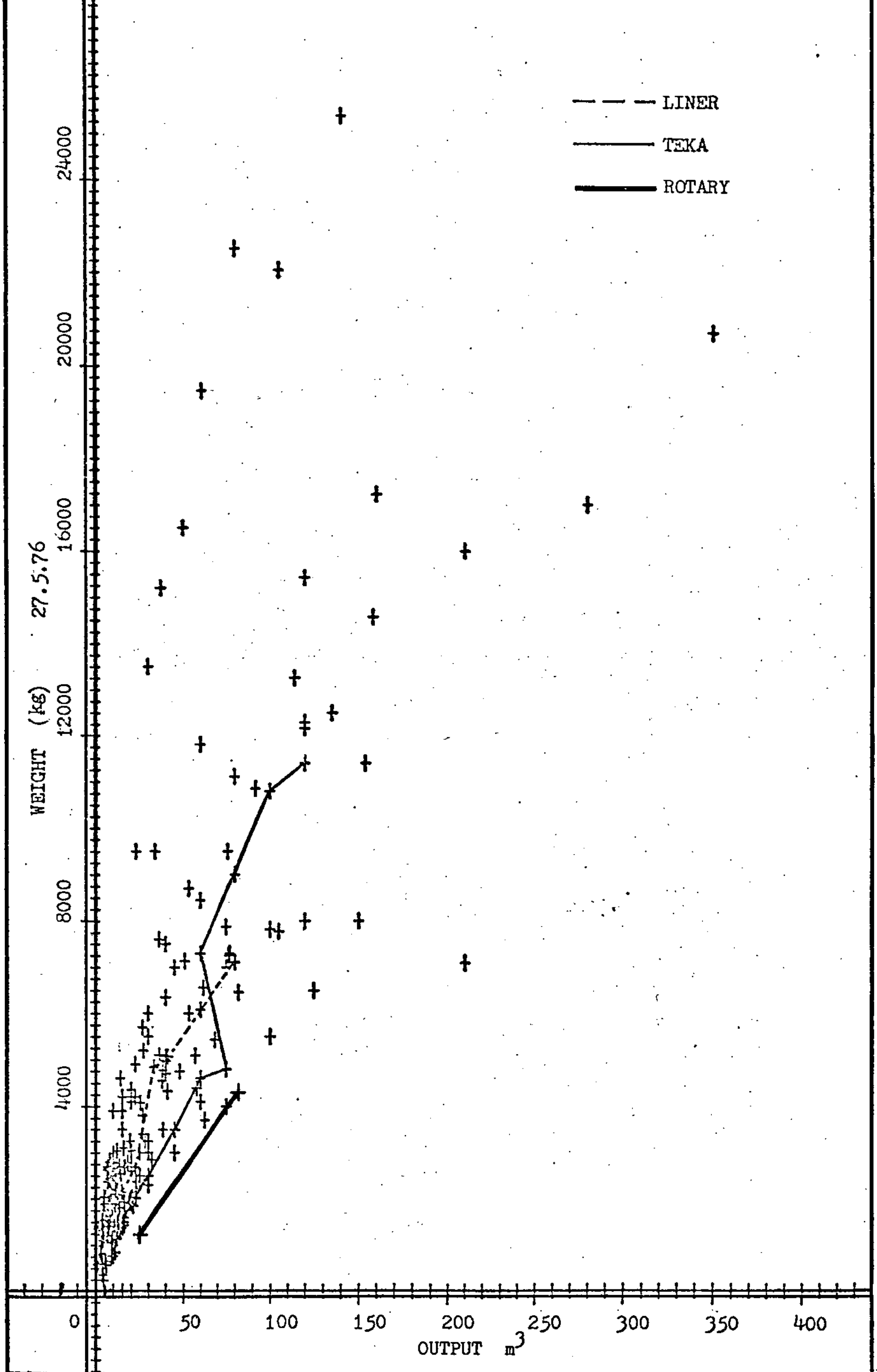


Plot 14.4



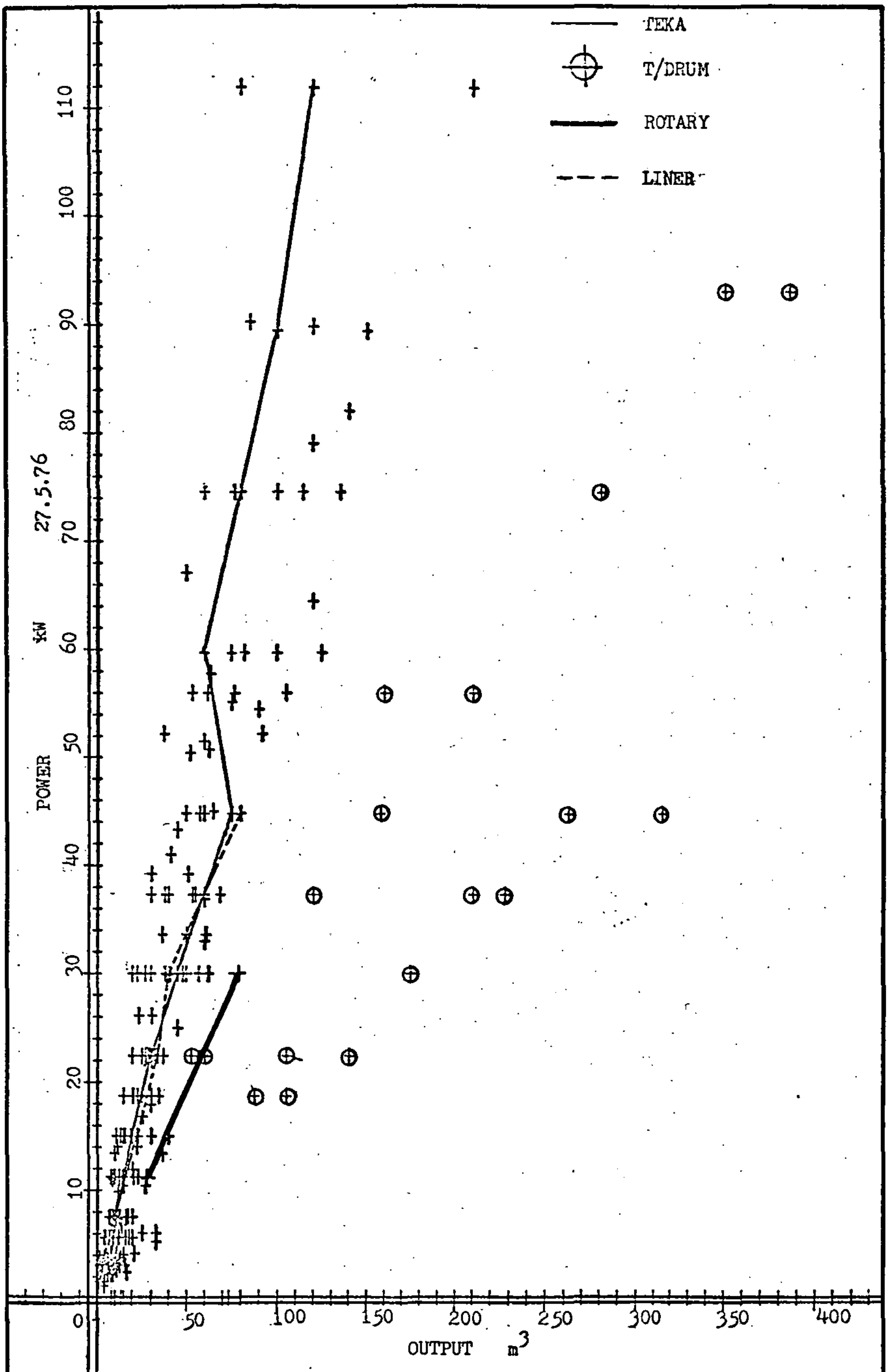
POWER AGAINST NOMINAL CAPACITY

Plot 14.5



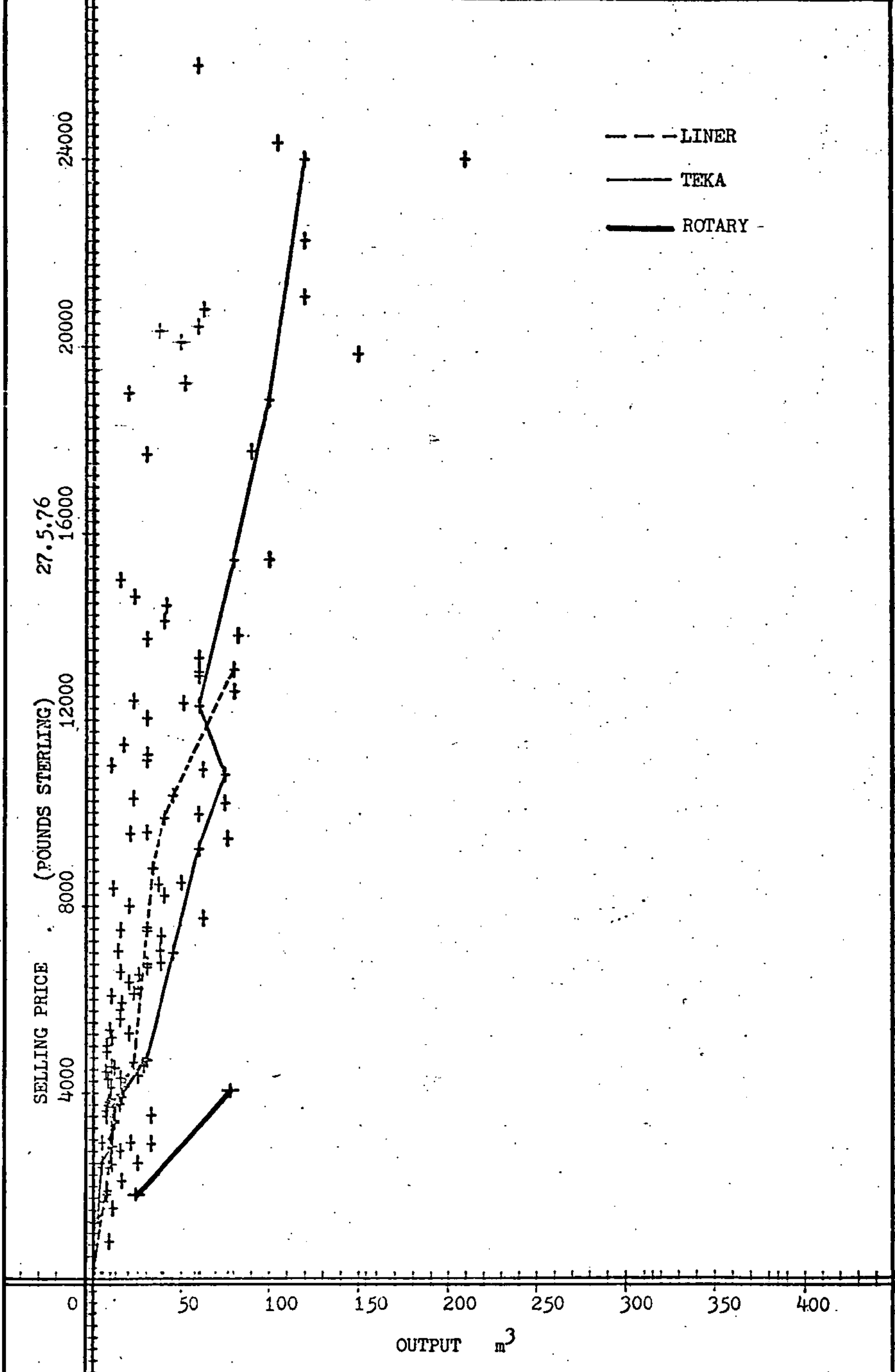
WEIGHT AGAINST OUTPUT

Plot 14.6



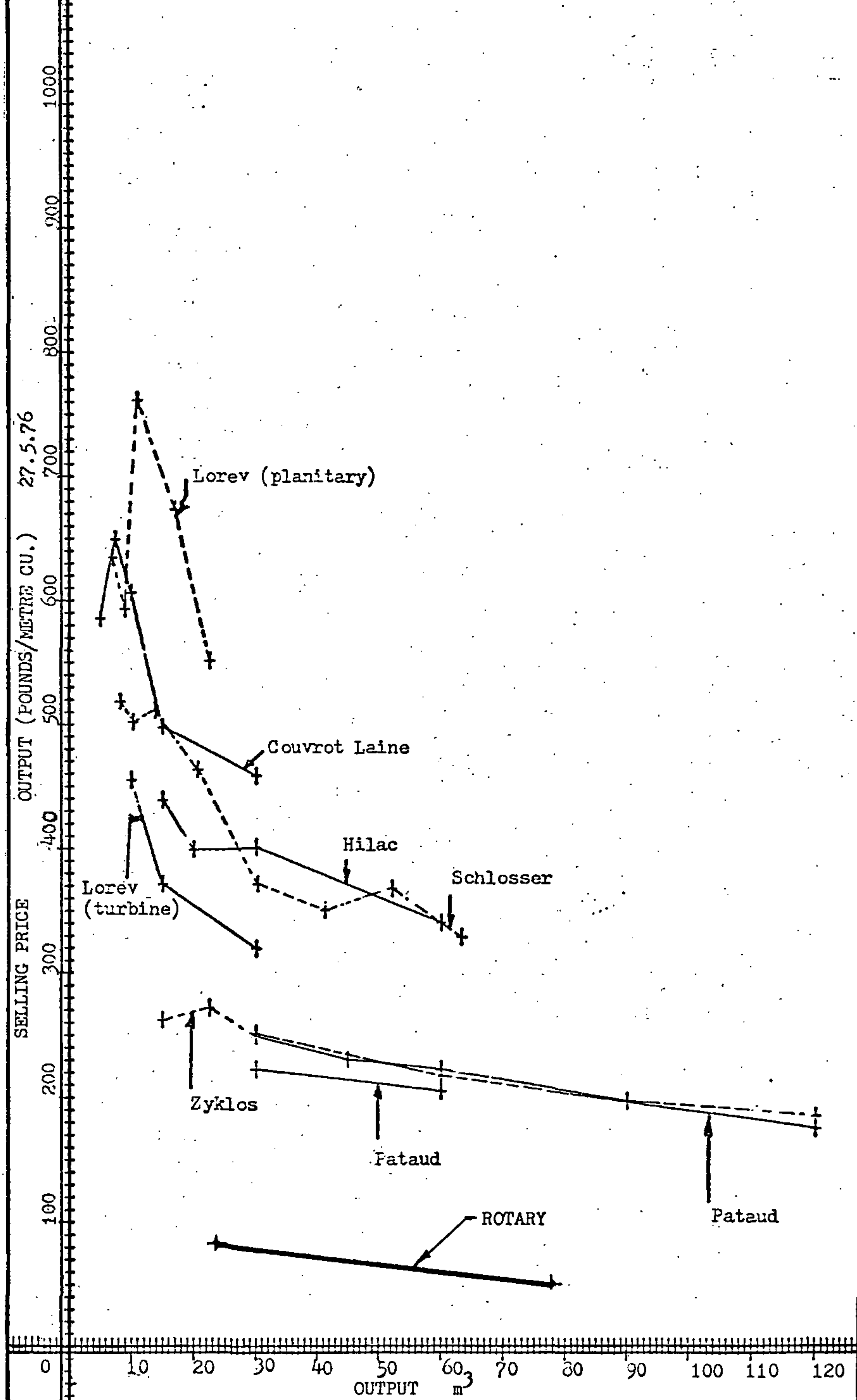
POWER AGAINST OUTPUT

Plot 14.7



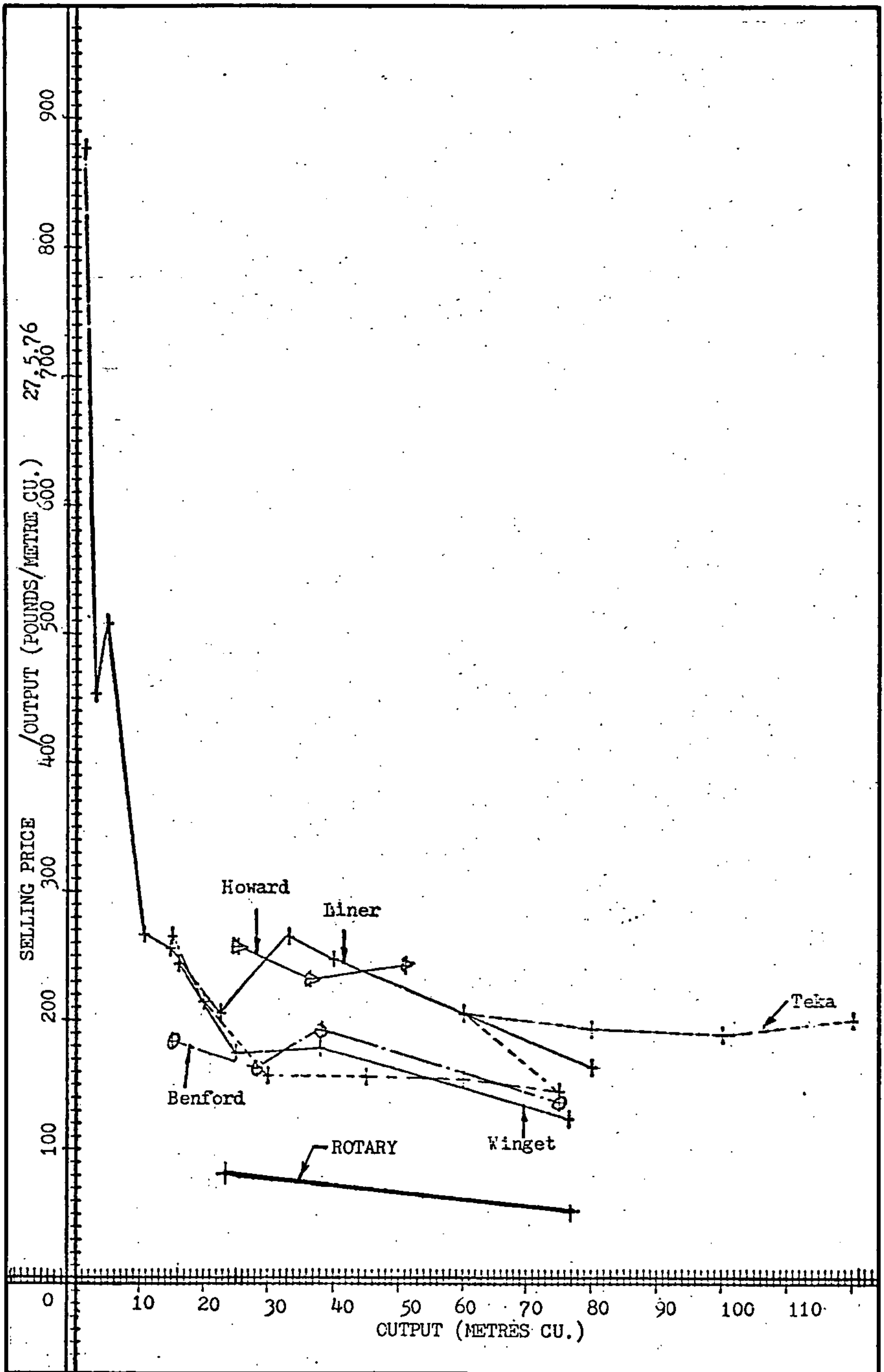
SELLING PRICE AGAINST OUTPUT

Plot 14.8



OUTPUT (METRES CU.)

Plot 14.9



SELLING PRICE AGAINST OUTPUT

Plot 14.10

APPENDIX

B

RELEVANT BRITISH STANDARDS

APPENDIX B

RELEVANT BRITISH STANDARDS

A. CEMENT

B.S. 12 : 1958 Portland cement (ordinary and rapid-hardening) (metric version, 1971).

146 : 1958 Portland-blastfurnace cement (metric version, 1973).

1370 : 1958 Low heat Portland cement (metric version, 1974).

4246 : 1968 Low heat Portland-blastfurnace cement (metric version, 1974).

4248 : 1974 Supersulphated cement.

915 : 1947 High alumina cement (metric version, 1972).

1014 : 1961 Pigments for cement, magnesium oxychloride and concrete.

B. AGGREGATES

B.S. 882, 1201 : 1965 Aggregates from natural sources for concrete including granolithic).

812 : 1967 Methods for the sampling and testing of mineral aggregates, sands and fillers.

887 : 1969 Foamed or expanded blastfurnace slag lightweight aggregate for concrete (metric version, 1973).

1047 : 1952 Air-cooled blastfurnace slag coarse aggregate for concrete (metric version, 1974).

1165 : 1966 Clinker aggregate for concrete.

410 : 1969 Test sieves.

3797 : 1964 Lightweight aggregates for concrete.

3681 : 1963 Methods for sampling and testing of lightweight aggregates for concrete (metric version, 1973).

C. CONCRETE

B.S.1881 : Part 1 : 1970 Methods of sampling fresh concrete.

1881 : Part 2 : 1970 Methods of testing fresh concrete.

1881 : Part 3 : 1970 Methods of making and curing test specimens.

1381 : Part 4 : 1970 Methods of testing concrete for strength.

1881 : Part 5 : 1970 Methods of testing hardened concrete for other than strength.

1881 : Part 6 : 1971 Analysis of hardened concrete.

4408 : Part 1 : 1969 Electromagnetic cover measuring devices.

4408 : Part 2 : 1969 Strain gauges for concrete investigations.

4408 : Part 3 : 1970 Gamma radiography of concrete.

4408 : Part 4 : 1971 Surface harness methods.

4408 : Part 5 : 1974 Measurement of the velocity of ultrasonics pulses in concrete.

1926 : 1962 Ready-mixed concrete.

1305 : 1974 Batch type concrete mixers.

3963 : 1965 Method for testing the performance of batch type concrete mixers.

368 : 1971 Precast concrete flags.

2028, 1364 : 1968 Precast concrete blocks.

1348 : 1959 Tests for water for making concrete.

APPENDIX

C

LIST OF RELEVANT A.S.T.M. STANDARDS

APPENDIX C

SELECTED LIST OF RELEVANT A.S.T.M. STANDARDS

A. CEMENT

C 150-74	Spec. for Portland Cement.
C 595-74	Spec. for Blended Hydraulic Cements.
C 115-74	Test for Fineness of Portland Cement by the Turbidimeter.
C 186-73	Test for Heat of Hydration of Hydraulic Cement.
C 151-74a	Test for Autoclave Expansion of Portland Cement.

B. ADMIXTURES

C 618-73	Spec. for Fly Ash and Raw or Calcined Natural Pozzolans for Use in Portland Cement Concrete.
C 494-71	Spec. for Chemical Admixtures for Concrete.
C 441-69	Test for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali-Aggregate Reaction.
C 260-73	Spec. for Air-Entraining Admixtures for Concrete.

C. AGGREGATES

C 294-69	Descriptive Nomenclature of Constituents of Natural Mineral Aggregates.
C 33-74	Spec. for Concrete Aggregates.
C 330-69	Spec. for Lightweight Aggregates for Structural Concrete.
C 331-69	Spec. for Lightweight Aggregates for Concrete Masonry Units.
C 332-66	(1971) Spec. for Lightweight Aggregates for Insulating Concrete.

C 117-69	Test for Materials Finer than No. 200 (75-μm) Sieve in Mineral Aggregates by Washing.
C 70-73	Test for Surface Moisture in Fine Aggregate.
C 40-73	Test for Organic Impurities in Sand for Concrete.
C 123-69	Test for Lightweight Pieces in Aggregate.
C 88-73	Test for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.
C 131-69	Test for Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine.
C 289-71	Test for Potential Reactivity of Aggregates (Chemical Method).
C 227-71	Test for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
C 586-69	Test for Potential Alkali Reactivity of Carbonate for Concrete Aggregates (Rock Cylinder Method).
C 638-73	Descriptive Nomenclature of Constituents of Aggregates for Radiation-Shielding Concrete.
C 636-73	Spec. for Aggregate for Radiation-Shielding Concrete.
E 11-70	Spec. for Wire-Cloth Sieves for Testing Purposes.

D. <u>CONCRETE</u>

C 124-71	Test for Flow of Portland Cement Concrete by Use of the Flow Table (discontinued 1974).
C 143-71	Test for Slump of Portland Cement Concrete.
C 360-63	(1968) Test for Ball Penetration in Fresh Portland Cement Concrete.
C 403-70	Test for Time of Setting of Concrete Mixtures by Penetration Resistance.
C 232-71	Test for Bleeding of Concrete.

C 138-74	Test for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.
C 173-73a	Test of Air Content of Freshly Mixed Concrete by the Volumetric Method.
C 231-73	Test for Air Content of Freshly Mixed Concrete by the Pressure Method.
C 470-73T	Spec. for Moulds for Forming Concrete Test Cylinders Vertically Concrete Test Cylinders.
C 192-69	Making and Curing Concrete Test Specimens in the Laboratory.
C 39-72	Test for Compressive Strength of Cylindrical Concrete Specimens.
C 617-73	Capping Cylindrical Concrete Specimens.
C 78-64	(1972) Test for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
C 496-71	Test for Splitting Tensile Strength of Cylindrical Concrete Specimens.
C 42-68	(1974) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
C 215-60	(1970) Test for Fundamental Transverse, Longitudinal and Torsional Frequencies of Concrete Specimens.
C 418-68	(1974) Test for Abrasion Resistance of Concrete.
C 85-66	(1973) Test for Cement Content of Hardened Portland Cement Concrete.
C 457-71	Rec. Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete.
C 666-73	Test for Resistance of Concrete to Rapid Freezing and Thawing.
C 94-74	Spec. for Ready-mixed Concrete.
C 156-74	Test for Water Retention by Concrete Curing Materials.

T - denotes Tentative Standard. The two digits after the dash denote the year of publication.

APPENDIX

D

LITERATURE ON STRUCTURAL FAILURE

APPENDIX D

LITERATURE ON STRUCTURAL FAILURE

1. Lessons from Failures of Concrete Structures, by Jacob Feld
   Published by American Concrete Institute.

2. Construction Failure, by Jacob Feld
   Published by John Wiley & Sons.

3. Building Failures, by Thomas H. McKaig
   Published by McGraw Hill Book Company.

4. Engineering Structural Failures, by Rolt Hammond
   Published by Odhams Press Ltd.

APPENDIX

E

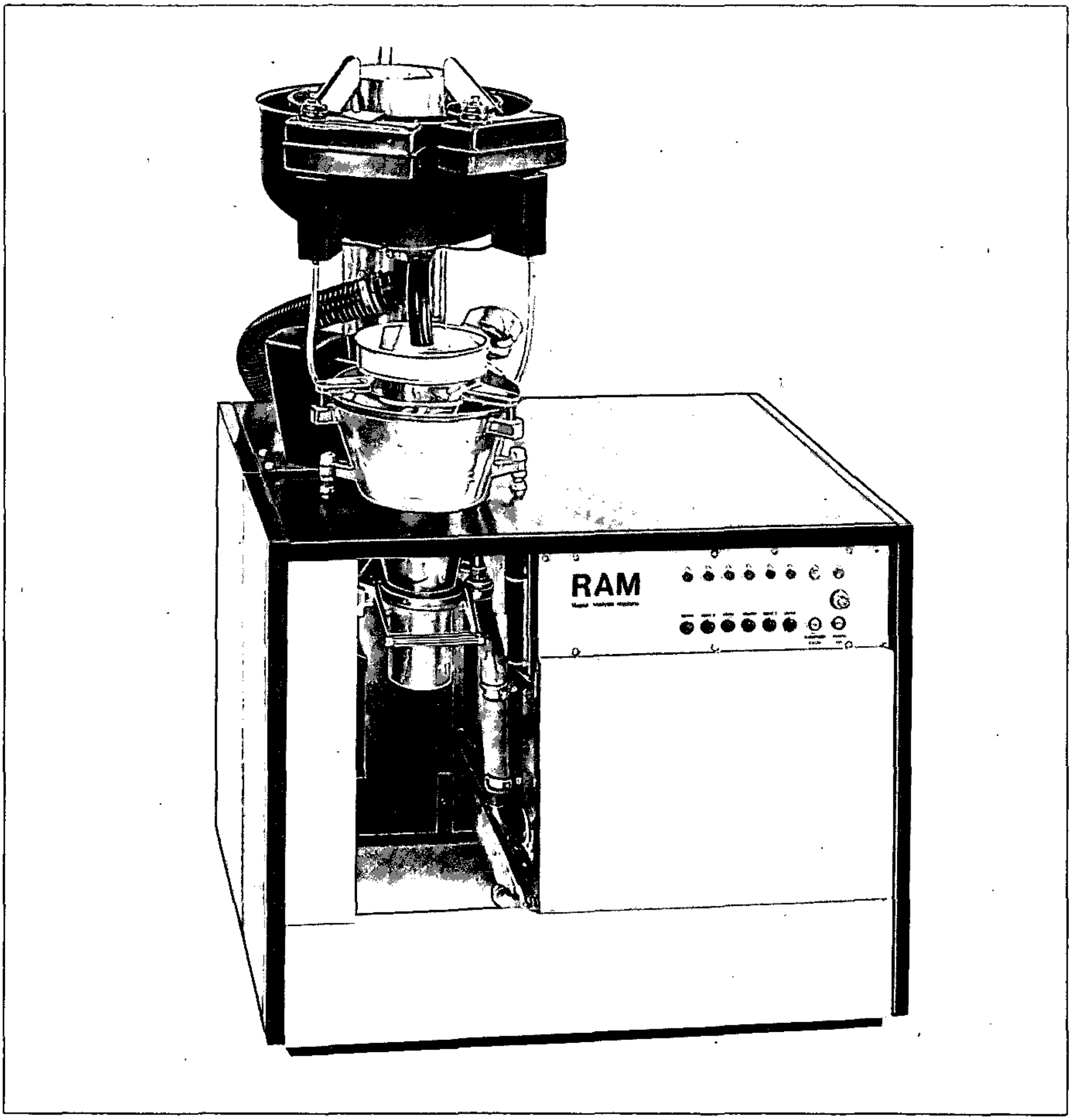
RAPID ANALYSIS MACHINE

Wexham
Developments
Limited

Product information

RAM

Rapid analysis machine



○ Speed

○ Simplicity

○ Accuracy

A practical method of determining the cement content of fresh concrete in the short time available between mixing and placing.

Product information

Rapid analysis machine

Introduction

The Rapid Analysis Machine (RAM) was developed by the Cement and Concrete Association of Great Britain as a quick method of assessing the cement content of fresh concrete. Recent work undertaken in the UK to ensure that effective standards of site quality control of concrete are maintained, has resulted in attention being focused on the analysis of fresh concrete and the specification of a minimum cement content as a contributing factor in ensuring adequate durability. If analysis shows that the cement content is below the acceptable level, the concrete can be rejected with minimum cost and delay.

The RAM has the advantage of being fully automatic once loaded and can be used by a junior technician. The sample can be taken in exactly the same way as for concrete cubes and the complete operation, from loading to reading the results off a calibration graph takes only 10 minutes, with the actual operating cycle taking as little as 5 minutes.

The accuracy of the RAM has been demonstrated in the laboratory where tests on a large number of machines have shown that the cement content can be measured to within 5 kg/m³. In the field, other variables, such as the presence of silt and the method of sampling will alter the accuracy, but it is normally possible to obtain an overall accuracy within 10 - 20 kg cement per cubic metre of concrete.

Figure 1. Rapid Analysis Machine

Description

The RAM is a floor mounted portable unit with dimensions of 1410 x 970 x 725 mm and weighing 160 kg. The RAM has a welded steel frame and the working parts are shown diagrammatically in Figure 2. The electrical controls are mounted on the front of the unit in a watertight box containing a sequence timer to control the operating cycle which is itself started by a push button. Situated in the base of the machine is a water tank which is large enough to allow one complete test to be performed without it having to be refilled. The RAM requires a clean water supply and is designed to operate from a 110 volt 50 Hz single phase electrical supply as standard, in order to comply with recognised safety regulations. For those laboratories with a 240 volt supply, a step-down transformer is offered as an accessory. The machine can also be supplied for use on 110 V, 60 Hz, single phase.

Operating cycle

The following sequence is illustrated on the next page.

1 The machine is loaded with an 8 kg sample of fresh concrete and the operating cycle is started by pressing a push button. Every machine is controlled automatically by a sequence timer.

2 Water is pumped through the sample at a controlled rate to wash the finer cement particles up and over the weir at the top of the elutriation column. Three sampling channels take off a 10% sample and the rest goes to waste.

3 The sample passes through a 150 micron sieve and into the conditioning vessel. The pump stops when all the cement has been washed from the sample. The suspension in the conditioning vessel now contains 10% of the cement from the original sample.

4 Chemical agents are mixed into the suspension, making the cement particles cling together and sink quickly to the bottom of the constant volume vessel. The water level is then lowered by means of a coarse and then a fine siphon, leaving a fixed volume of liquid plus cement in the constant volume vessel.

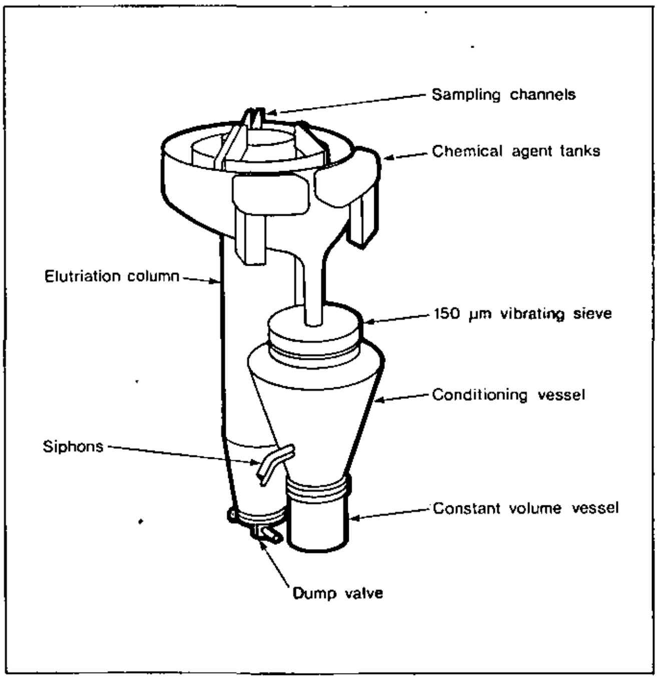


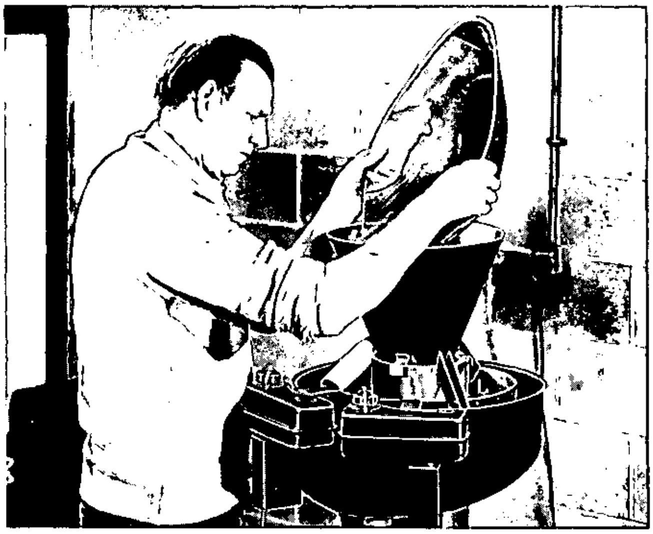
Figure 2. Diagram of working parts

5 The constant volume vessel is removed, weighed, and the cement content of the original sample determined from a calibration graph (6) after making a correction for any other material of cement-fineness which may be in the mix, such as silt or pulverised fuel ash.

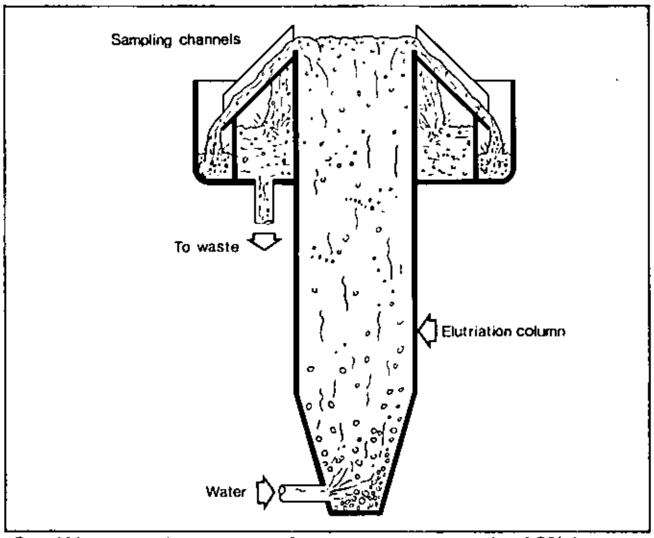
The total time from loading the machine to reading off an accurate answer from the graph is less than 10 minutes.

Rapid analysis machine

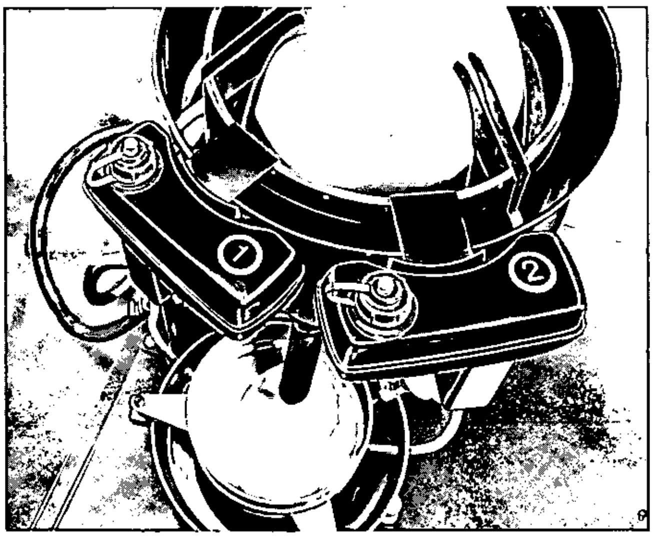
Illustrations of operating cycle



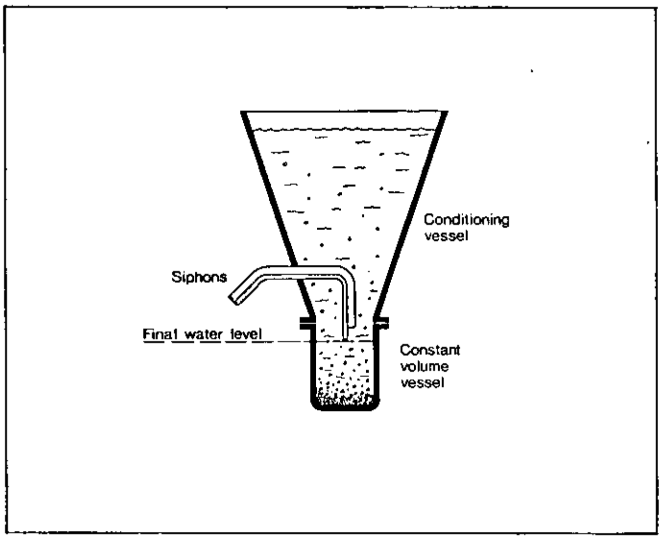
1 The machine is loaded with 8 kg of fresh concrete.



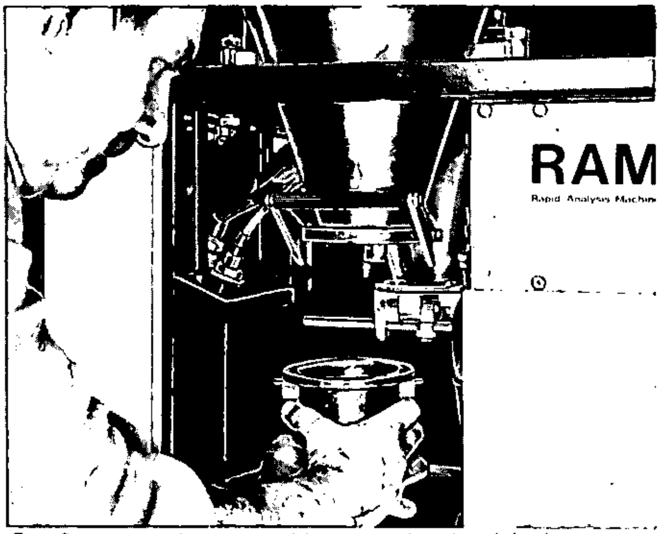
2 Water washes cement from concrete sample. 10% is channelled off. The rest goes to waste.



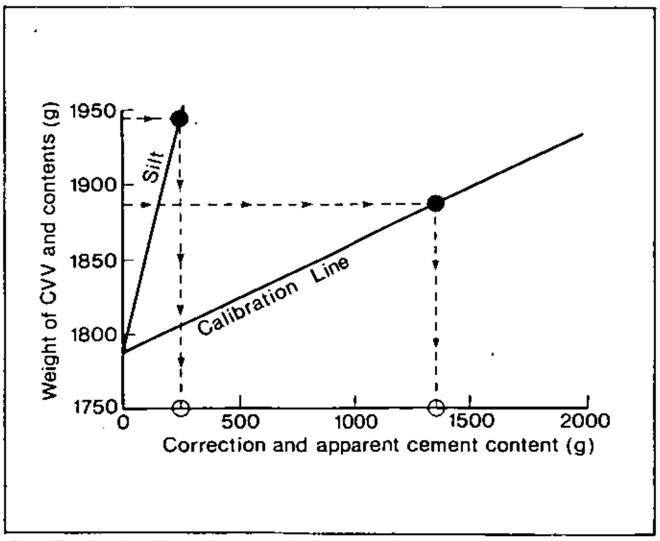
3 Concrete sample passes through sieve and into conditioning vessel.



4 Chemical agent is added and cement sinks into constant volume vessel. Water level is lowered by siphons.



5 Constant volume vessel is removed and weighed.



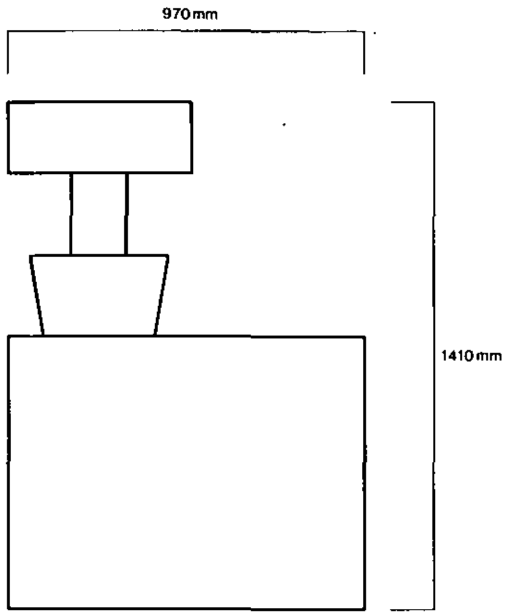
6 Typical calibration graph from which cement content is determined.

Product information

Rapid analysis machine

Specification

Approximate dimensions	1 410 x 970 x 725 mm (height x width x depth)
Pump rating	0.75 h.p.
Capacity of water tank	110 litres
Sieve dimensions	150 microns, 200 mm diameter
Weight	160 kg



Purchase details

Rapid Analysis Machine, for use on 110 V, 50 Hz, 1 ph, supplied complete with items RS/1 - 5
(60 Hz models also available)

RS/1 **RAM instruction manual**

RS/2 **RAM slide set**

RS/3 **Spare nozzle pack**

RS/4 **Chemical Agent 1**
(Sufficient for 150 tests)

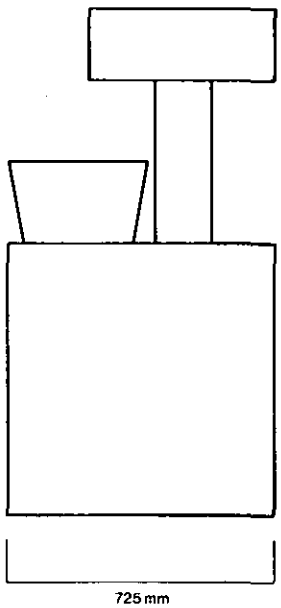
RS/5 **Chemical Agent 2**
(Sufficient for 150 tests)

RS/6 **Twin beam scales 2710 g x 0.1 g** for weighing constant volume vessel

RS/7 **Set of weights** for item RS/6

RS/8 **Laboratory scales 10 kg x 1.0 g** for weighing original concrete sample

RS/9 **Step-down transformer** to enable RAM to be used on 240 V, 50 Hz, 1 ph supply



Wexham Developments Limited

P.O. Box 52
Slough SL3 6PL

Telephone: Fulmer 2130/2727
Telex: 848352

APPENDIX

F

QUESTIONNAIRES

UNIVERSITY OF TECHNOLOGY
Loughborough, Leicestershire

Dear Sir,

We are at present engaged on a survey of concrete mixing and production methods.

This survey is intended to provide information from the users of this equipment and from the specifiers of concrete, on the present state and likely future developments in these areas.

We will be grateful if you will respond to this survey as it will give you the opportunity of influencing developments in the design of plant and services for the industry.

All detailed information given will be greated in strictest confidence.

Should you wish to remain anonymous please detach the code number slip from the bottom of the last page of the questionnaire, this code indicates the address to which the questionnaire was sent. If you do not mind being identified in more detail please fill in identification question.

The information gained from this survey will be used to compile a more detailed questionnaire of likely future developments. If you would be prepared to take part in this further survey please complete last question.

The evaluation of the questionnaire will begin on March 28th 1977, but return before this date would be of great assistance.

We would like to thank you for your co-operation in helping us with this important survey.

Yours faithfully

M.E. PRESTON

Enc.- s.a.e. and questionnaire

CONCRETE MIXING AND PRODUCTION SURVEY

GENERAL

If questions indicate a choice please tick appropriate box.
If you do not wish to answer a question carry on to the next.

1. PRODUCT DATA

Please indicate the products made by your company, if more than one product indicate approximate percentage split by volume of concrete produced.

Product Code	%	Product Code	%	Product Code	%
System Building		Concrete Products		Site Concrete	
Structural Concrete		Ready Mixed Concrete		Pipes	
Piles		Other. specify			

PRODUCTION RATE

What is your yearly output of concrete [ ] Cu. Metres

2. PLANT DATA

What are the types, output, and ages of concrete mixers used in your works? Do they incorporate automatic water control, is it effective? Do the mixers use steam injection? If not do you intend to fit it within the next 3 years?

Mixer Type Teka, Liner Etc.	Output Cu.Metre/ Batch	Age Years	Automatic water control				Steam Injection			
			Fitted		Effective		Fitted		Intend to fit	
			Yes	No	Yes	No	Yes	No	Yes	No

3./........

3. BATCHING PLANT

What type of Batching Plant do you use?

TYPE OF PLANT		TYPE OF CONTROL			FITTED	AGE
FIXED	MOBILE	MANUAL	SEMI AUTOMATIC	AUTOMATIC	MIXER	YEARS

4. WASTE CONCRETE DISPOSAL

What type of waste concrete disposal system do you use if any?

TYPE OF SYSTEM	USE	TYPE OF SYSTEM	USE
None		Automatic Recovery Unit	
Settling Pits		Other type - please specify below	

5. TYPE OF MIX

What type of mixes do you use/supply most frequently and their proportion of total output.

MIX PARAMETERS	DETAILS			
SLUMP mm				
WATER/CEMENT RATIO				
ADMIXTURE TYPE (CODE)*				
PROPORTION OF OUTPUT (%)				
CODE FOR ADMIXTURE	1=Water Reducing; 2=Accelerator; 3=Retarder;			
	4=Waterproofer;5=Plasticiser;6=Pigment;7=PFA			
OTHER TYPE PLEASE SPECIFY				

6./........

6. CRITERIA FOR MIXER PURCHASE

	CRITERIA		CRITERIA
1	Price	6	Availability
2	Modern Design	7	Availability of correct size
3	Economy of operation	8	Environmental (dust free)
4	Ease of maintenance	9	Suitable discharge door position
5	Speed of mixing	10	Quality of mixing

Please select from the above criteria the 3 most important when purchasing your next mixer. Rate these 3 criteria in order of importance.

← Most important Least important →

Please select from the above criteria the 3 least important when purchasing your next mixer. Rate these 3 criteria in order of importance.

← Most important Least important →

7. NEW DEVELOPMENTS

Do you use or intend to use any of the following in the next 3 years?

Development Concrete Type	Intend to use		At present in use			
			Amount	Expected trend over next 3 years		
	Yes	No	Cu.Metres	Increase	Stable	Decrease
Lightweight						
Steel Fibre						
Glass Fibre						
Plasticiser						
Polymer						

8./.........

8. FUTURE DEVELOPMENTS

Please give your ideas on the future developments in your industry or in the concrete industry in general, please indicate likely time scale.

9. GENERAL COMMENTS

Do you have any comments on the present available concrete mixers or associated plant? Are you satisfied with your present plant, if not please state why. Are there any improvements or developments you would like to see?

(If required please continue on reverse side)

10./........

10. IDENTIFICATION

COMPANY: ....

ADDRESS: ....

....

GROUP: ....

NAME OF RESPONDENT: ....

JOB IDENTIFICATION: ....

11. FUTURE QUESTIONNAIRE

Are you willing to take part in a more detailed questionnaire on the future of the concrete industry and future developments in plant?

YES		NO	

NOTE: If yes, please be sure to fill in section 10 above.

MANY THANKS FOR YOUR CO-OPERATION

PLEASE REPLY TO:

M.E. PRESTON,
ENGINEERING DESIGN CENTRE,
LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY,
LOUGHBOROUGH,
LEICESTERSHIRE,
LE11 3TU.

Telephone; 0509 68013 Ext 6.

CODE No.

CONCRETE MIXING AND PRODUCTION SURVEY

LINER PERSONNEL

1. CRITERIA FOR MIXER PURCHASE

	CRITERIA		CRITERIA
1	Price	6	Availability
2	Modern Design	7	Availability of correct size
3	Economy of operation	8	Environmental (dust free)
4	Ease of maintenance	9	Suitable discharge door position
5	Speed of mixing	10	Quality of mixing

Please select from the above criteria the 3 most frequently stated as being important by your customers in the purchase of new mixers.
Rate these 3 criteria in order of importance.

← Most important Least important →

Please select from the above criteria the 3 least frequently stated as being important by your customers in the purchase of mixers.
Rate these 3 criteria in order of importance.

← Most important Least important →

2. ADDITIONAL CRITERIA

Please give any additional criteria which you or your customers consider important when purchaseing a new mixer.

3. PRESENT EQUIPMENT

Moisture Control

Do you consider that present methods of water control used in concrete mixing to be satisfactory.

Yes		No	

If No please state most common complaints.

Steam Injection

Have you ever lost a mixer sale due to steam injection not being available on Liner mixing plant.

Yes		No	

If yes please give number of sales.

4. NEW PLANT DEVELOPMENTS

Have any new developments taken place in the plant sector which you consider to be important and that the company should take note of in future development (This includes both mixing and batching plant also in any other part of the plant industry which is relevant to concrete or Liner.)

5. NEW DEVELOPMENTS IN CONCRETE

Have you been called upon to supply or quote for mixers or batching plant for any of the new developments listed below;

5.1	Lightweight concrete	Yes		No	
	Comments.				
5.2	Steel fibre reinforced concrete	Yes		No	
	Comments.				
5.3	Glass fibre reinforced concrete	Yes		No	
	Comments.				
5.4	Super Plasticiser concrete	Yes		No	
	Comments.				
5.5	Polymer concrete	Yes		No	
	Comments.				

6. NEW DEVELOPMENTS IN CONCRETE

Please note any other new developments in concrete which you think should be considered in new plant designs.

7. COMPLAINTS FROM CUSTOMERS

In the last 3 years what are the most common complaints from your customers of mixing and batching plant. (Both produced by Liner and by any other company)

8. COMPLIMENTARY REMARKS

In the past 3 years what are the most common compliments payed to you on Liner mixing and batching plant.

What are the features most often praised in other manufacturer's equipment.

9. NON CONCRETE APPLICATIONS OF MIXING AND BATCHING PLANT

Please give details of any non concrete applications of mixing and batching plant supplied in your area also any problems encountered with these applications.

10. LOCAL PROBLEMS

Please give details of any local problems in your area which affect the design of mixing and batching plant.

11. FUTURE OF CONCRETE INDUSTRY

How do you see the future of the concrete industry ,in both the short and long term. Do you have any ideas on new plant requirements in the next 5 years.

I2. <u>GENERAL COMMENTS</u>

Please list any points which you feel have not been covered by the questionnaire,your comments on the whole range of Liner products may be included.

Please return this questionnaire to;	IDENTIFICATION
M.E.PRESTON	NAME................................
ENGINEERING DESIGN CENTRE	ADDRESS ....
LOUGHBOROUGH UNIVERSITY	....
LOUGHBOROUGH	....
LEICESTERSHIRE	....
LEII 3TU	JOB IDENTIFICATION................
Telephone; 0509 680I3 Ext 6.	....

APPENDIX

G

SUMMARY OF POSTAL SURVEY RESULTS

APPENDIX G

SUMMARY OF POSTAL SURVEY RESULTS

A summary is given below of the main points made under each of the headings shown as detailed in answers to the postal questionnaire.

Timing of the Upturn in the Construction Industry

The majority of answers indicate the time of the upturn will take place in the years 1980-1982.

1. Health and Safety at Work

   a. Present products do not comply (manufacturers no help).

   b. Likely to be increase in requirements in next ten years.

   c. Noise, increase in requirements.

   d. Dust, mainly complaints about Liner Cumflow.

2. Maintenance

   a. Rust proofing of plant structures/use of concrete.

   b. General maintenance, Teka expensive, difficult to overhaul mixers, needs improving, must be easy or it gets neglected, automatic (foolproof), needs reducing.

   c. Wear rates, generally considered to be high.

   d. Cost of spare parts excessive.

3. Complimentary Remarks on Equipment Other Than Liner

   In order of popularity:

   1. Door position.
   2. Lower cost of other machines.

      Portable batching system.
   3. Modular design.

      Dust covers.

      Smaller size allows fitment into existing plant.

      Method of discharge.

4. Hydraulic operation.

High quality of quotation presentation.

Offers of discount.

4. Site Mixing v. Ready Mixed Concrete

1. Economics of distribution.
2. Variations in rate of delivery.
3. Initial cost of mixer related to overall volume.
4. Present condition favour R.M.C.
5. Possible swing to site mixing.

5. Needs

1. Small mixer required 10/7 (simple).
2. Small Giraffe.
3. Choice of porta saw.
4. Modular design on mixers. (At moderate cost.)
5. Small site mixer (similar to Parker type).
6. Waste recycling system.
7. .75 m^3 mobile mixer operated by one man.
8. Easy to erect plant.
9. Mobility needed (mostly from Liner salesmen).
10. Automatic water control.

6. New Developments in Concrete

a. Depletion of natural aggregates (particularly S.E.) indicates high production plants based on rail or ports, started 2/3 years ago, complete in 10/15 years.

b. Good aggregates should be reserved for High Strength concrete, cement used to stabilize waste material. (Equipment needed to handle above.)

c. Use of plastic insulation material in thermal blocks.

7. Superplasticisers

a. Indicates a rapid increase in their use, due to increase in cement prices.

b. Improved control required, dispensers required.

8. P.F.A./Cement Blend

a. Increased use.

b. Reduces heat of hydration.

9. Lightweight Aggregates

a. Increase use for thermal and special purpose, limited by cost for structural use.

b. Not readily available.

c. Problems of weighing and mixing.

10. G.R.C. and S.R.C.

a. Increase in use but small mainly due to difficulty in mixing.

b. G.R.C. needs developing into structural material (next 5 years).

c. Requirement for special purpose M/C.

11. Quality Control

a. Increased Q.C. required.

b. Q.C. by wet analysis used more.

c. Consequences not appreciated on high production rate sites.

12. Water Control

a. Needs to be improved.

b. More effective methods needed.

c. Quick and accurate method of moisture measurement in aggregates needed.

13. Slump Control

a. Effective method of control needed.

b. Automatic method required not related to water.

14. Automatic Systems

a. Control of inputs to mixer needed.

b. Foolproof as possible.

c. Reduce labour, (skilled) due to increase in cost.

d. Improve ancillary equipment.

e. *Full computor operated plants next 25 years.

f. Fitted but too slow, hence not used.

g. Full computor control needed, including issuing certified ticket.

h. Decline in site labour quality, hence need for automation.

i. Must be reasonably priced and reliable.

j. Efficient automation required.

* Most noted point in this section.

15. Liner

15.1 Company Image

a. Basically old fashioned (except Giraffe).

b. Attention needed to styling.

15.2 Workmanship

a. Poor on all equipment.

b. Poor inspection.

c. Badly fitting covers on machines.

d. Poor service.

e. Unsatisfactory performance.

f. Parts fall off equipment on delivery.

15.3 Sales

a. More flexible approach needed, particularly to discounts.

b. Reaction to changing market slow.

c. More feedback from sales force required, (i.e. simple questionnaire).

d. More market research required.

e. Better supply of machines required.

15.4 Cumflow

a. Elderly in design.

b. High price (3).

c. High cost of spares (7).

d. High cost of maintenance compared with other machines (4).

e. High wear rates (later machine) (1).

f. Maintenance takes too long and is poor (5).

g. Poor discharge door (1).

h. See also complimentary remarks.

15.5 Complimentary Remarks About Liner

a. Reliable (15).

b. Relatively low wear rates (9).

c. Quality of mixing (13).

d. Speed of mixing (2).

e. Ease of maintenance (1).

f. Long life (10).

g. Ease of operation (4).

h. Spares availability (2).

NOTE: Number in brackets indicates times mentioned in questionnaires.

APPENDIX

H

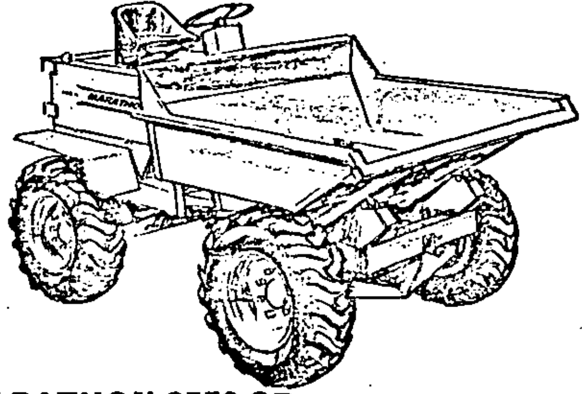
LINER PLANT

TYPE	TITLE	CAPACITY LITRES	DESCRIPTION
ROLPANIT	ROLLER PAN MIXERS	220 l	MORTAR & PLASTER MIXER
ROUGHRIDER	DUMPER 2WD	750 kg	OPTIONS ARE SWIVEL
ROUGHRIDER	DUMPER 2WD	1250 kg	SKIP, CRANE SKIP, HIGH
ROUGHRIDER	DUMPER 2WD	1500 kg	DISCHARGE, FIXED PLATFORM,
ROUGHRIDER	DUMPER 4WD	1375 kg	TIPPING PLATFORM.
MARATHON	DUMPER 4WD	2000 kg	
MARATHON	DUMPER 4WD	2550 kg	
PORTASAW	PORTABLE SAWBENCH	-	ELECTRIC OR DIESEL POWER
ROUGHRIDER	FORKLIFT 4WD	1270 kg	LIFT TO 5.5m
GIRAFFE	SITE PLACING VEHICLE	2032 kg	HEIGHT 6.91m REACH 1.09m HEIGHT 8.53m REACH 2.44m

Table H.1

TYPE OF MIXER	TITLE	CAPACITY		PHOTOGRAPHIC REF
		INPUT LITRES	OUTPUT LITRES	
TILTING DRUM	CADET HAND FEED	113	85	1
TILTING DRUM	ENSIGN HAND FEED	142	99	2
TILTING DRUM	JUNIOR HAND FEED	150	100	3
TILTING DRUM	MAJOR HAND FEED	240	170	4
TILTING DRUM	COMMANDER HOPPER FEED	285	200	5
TILTING DRUM	FLUITILT HOPPER FEED	285	200	6
REVERSING DRUM	FLUIVERSE HOPPER FEED	400	285	7
REVERSING DRUM	MARSHALL HOPPER FEED	600	400	8
PAN TYPE	CUMFLOW RP 100	57	40	9
PAN TYPE	CUMFLOW RP 200	184	117	9
PAN TYPE	CUMFLOW RP 400	400	254	9
PAN TYPE	CUMFLOW RP 550	566	360	9
PAN TYPE	CUMFLOW RP 850	850	540	9
PAN TYPE	CUMFLOW RP 1250	1250	796	9
PAN TYPE	CUMFLOW RP 1500	1500	955	9
PAN TYPE	CUMFLOW RP 3000	3000	1910	9

Table H.2

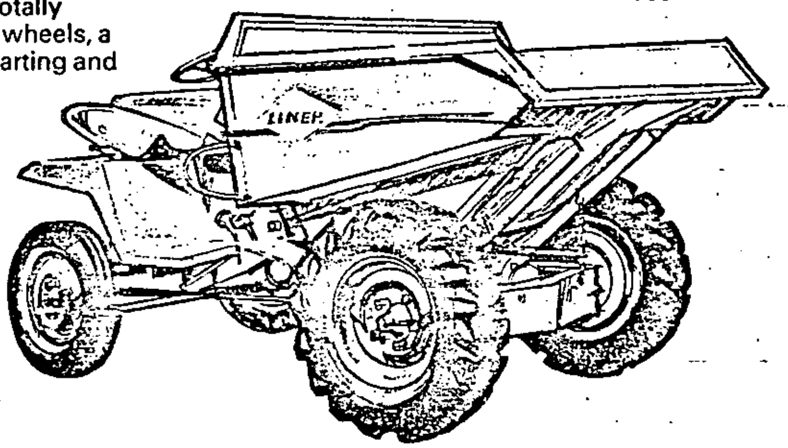


MARATHON 2550 SB

4 wheel drive diesel dumper

2550 kg carrying capacity with hydraulically tipped skip. 4 wheel drive and hydraulically assisted split-in-the-middle chassis steering enable even the worst sites to be negotiated. New features now include totally enclosed multi-disc brakes operating on all 4 wheels, a larger Lister ST3 diesel engine with electric starting and a fully sprung seat for the operator.

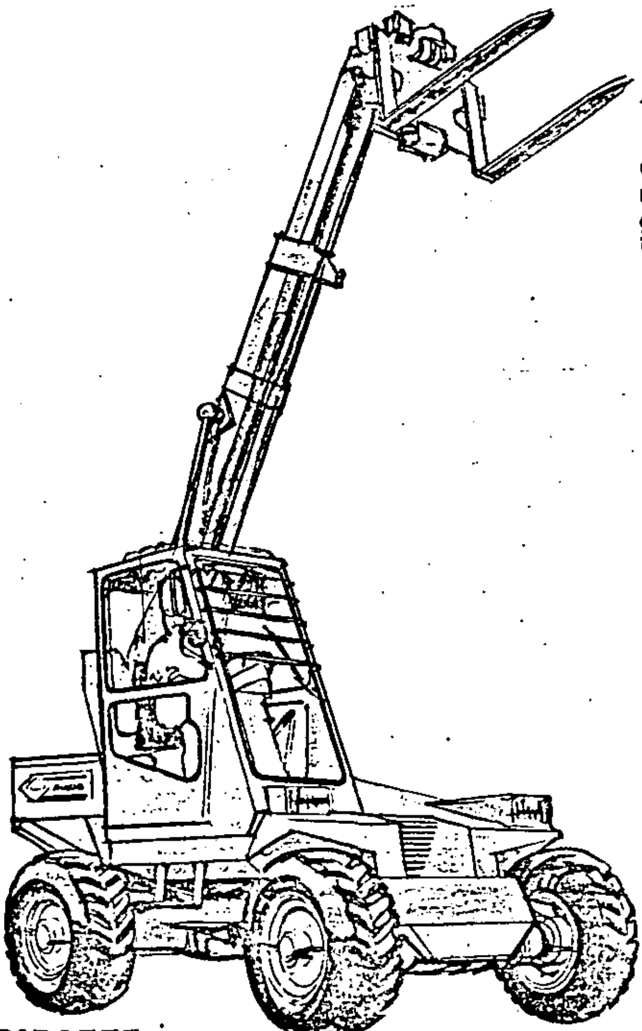
ROUGHRIDER 1500



ROUGHRIDER

750, 1250 and 1500 2 wheel drive diesel dumpers

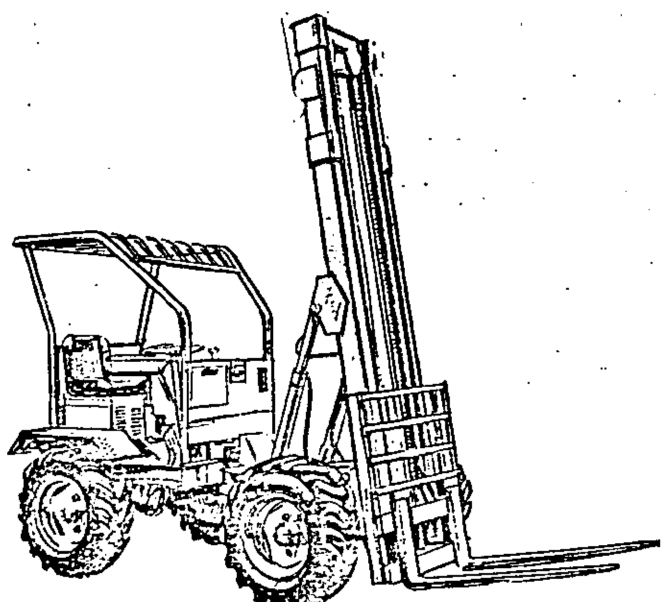
Diesel engine driven and robustly designed and constructed with capacities from 750 to 1500 kg to meet all needs. All-in-line transmission,two position gravity tipping heavy duty skip and engine house are included in the standard machine specification.



GIRAFFE

Site placing vehicle

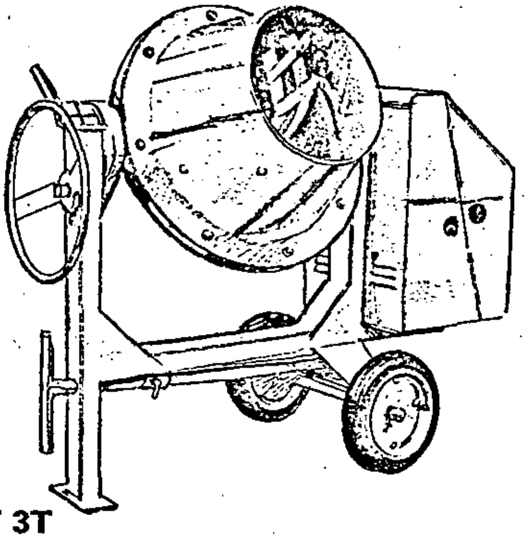
Unlike existing forklifts this exciting rough terrain vehicle has been designed without a fork mast. An extending telescopic boom with a variable position fork carriage at one end enables the operator to place materials precisely where they are required on site... up, down, forward or across.

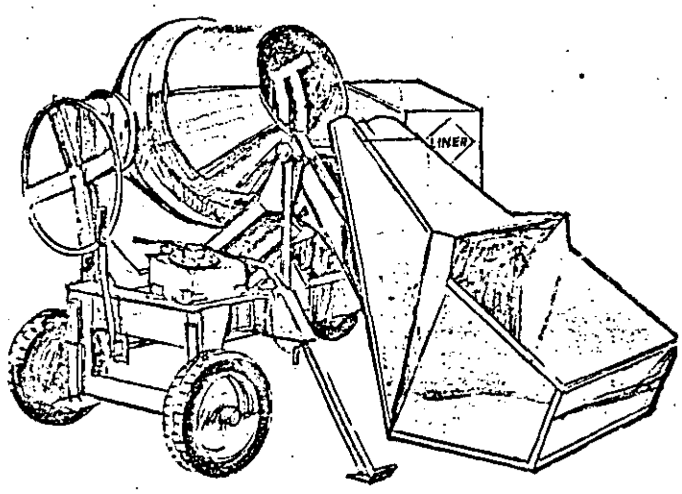


ROUGHRIDER

Forklift

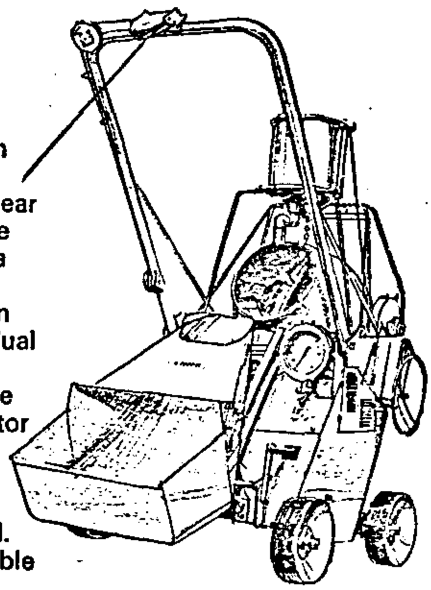
Lifts 1270 kg to a height of 5.5m. Smooth 4-wheel drive and wide profile stability tyres combined with centre pivot chassis steering gives anytime, anywhere manoeuvrability. Extras include large mortar pan crane jib and bottom discharge skip.



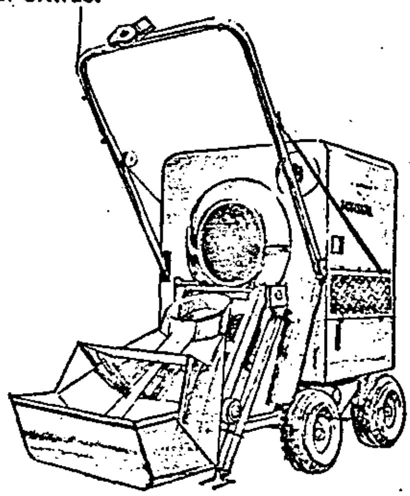


CADET 3T
Half-bag mixer
One-piece chassis. All steel mixing drum with 18" hand wheel. Gives up to 16 cubic yards of concrete plaster or mortar daily.

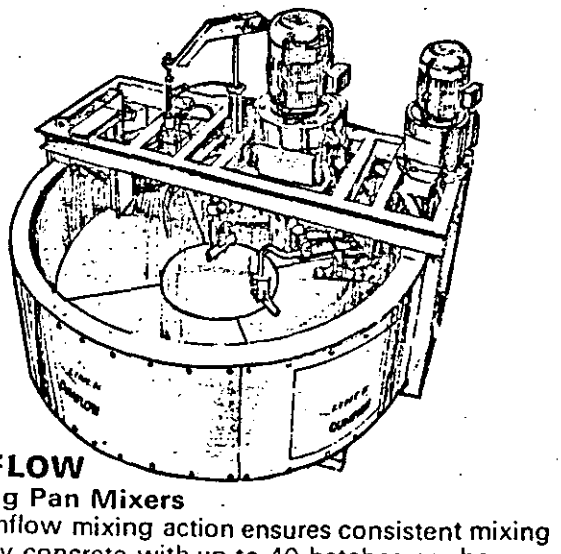
COMMANDER 7T
Hopper Fed mixer
All purpose site mixer simple and reliable in operation. Robust all steel construction throughout with either steel or pneumatic tyred wheels. Water meter and lifting hoist optional extras.



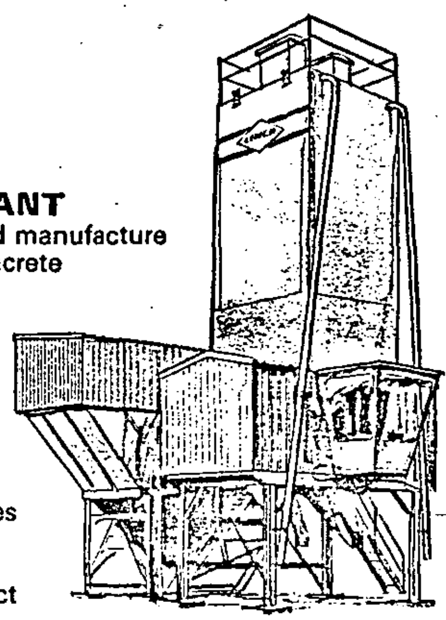
FLUITILT 7T
Hydraulic mixer
Patented mixing drum drive eliminates conventional chain, gear or vee-belt drives. The drum is mounted on a slow speed hydraulic motor and revolves on the motor shaft. The dual hydraulic pump is coupled directly to the engine or electric motor and feeds the drum, hopper and scraper shovel. Hydrostatic capsule weigher fitted. A water tank is available as an optional extra



MARSHAL 14NTR
FLUIVERSE 10NTR
Reversing drum mixers
On-site mixers for economic large scale production of quality concrete, complete with scraper shovel, batch weigher, loading hopper and feed apron.



CUMFLOW
Rotating Pan Mixers
The Cumflow mixing action ensures consistent mixing of quality concrete with up to 40 batches per hour when installed in an automated Batching Plant. Heavy duty renewable wearing plates are fitted along with patented cast chromium carbide mixing blades to give long service



BATCHING PLANT
Liner-Croker Limited manufacture a wide range of concrete batching plants with semi or fully automated controls.
Systems to suit the ready-mixed concrete, precast concrete and civil engineering industries have been designed and are produced to meet customers exact requirements.

APPENDIX

J

SPECIFICATION OF MIXING SYSTEM

APPENDIX J

SPECIFICATION OF MIXING SYSTEM

1.0 GENERAL

This specification is written to encompass a total mixing system. The specification is written into three main parts, these being:

1) Mixing and batching.

2) Mixer.

3) Batching.

2.0 MIXER AND BATCHING SYSTEM

In certain areas of the system, a common approach should be made to the system, these areas are detailed in this section. The areas which should be considered together are detailed below:-

1. Output.
2. Size.
3. Modulár design.
4. Safety.
5. Finish.
6. Cleaning.
7. Variety reduction.
8. Control.
9. Standards.
10. Maintenance.
11. Labour requirements.
12. Environmental.

2.1. OUTPUT OF SYSTEM

The total output of the batching system shall be matched to the output of the mixer. This shall not preclude the possible oversizing of the batching plant to allow for an increase in the mixer capacity.

2.1.1 Output of Mixer

In considering the market position as detailed in Appendix K, the following sizes of mixing machines were considered suitable for initial development.

a. Small mixer

The maximum output of the small mixer shall be 24 m^3/hr.

b. Large mixer

The maximum output of the large mixer shall be 60 m^3/hr, with a possible increase to 80 m^3 after an initial development stage.

NOTE: The larger mixer should be designed initially with the 80 m^3/hr output in mind to prevent any major redesign at later stages in the development program.

2.1.2 Variability of Mixer Output

Each machine has a minimum and maximum batch size. These sizes are mainly determined by the stator radius, this may be seen by examining Tables L1, L3 and L4 in Appendix L. If a 0.127 stator is used, the batch output is 0.083 m^3, but if the radius is increased to 0.178 then the batch output is 0.15 m^3. By using this idea to the full, the output of the two standard size machines may be varied simply by changing the stator radius. This makes the machine more versatile whilst retaining basically the same drive components.

2.1.3 Capacity Developments

The design of the system shall allow for development of the specified machines to larger capacities where possible. Possibly up to 27 m^3/hr and 81 m^3/hr respectively.

2.1.4 Output of Batching System

The output of the batching system should match the requirements of the mixer, the system should be capable of expansion upon the change of requirements of the mixing application.

2.2 SIZE

The overall size of the installation is to be as small as is consistent with the satisfactory operation of the equipment.

2.2.1 Mixer

The maximum sizes of the mixers are shown below. These dimensions have been determined from the need to replace existing mixers with the new mixer.

a. Small mixer

1.9 m Ø x 1.05 m high.

b. Large mixer

2.5 m Ø x 1.075 m high.

2.2.2 Batching Equipment

The size of the total batching system is to be as compact as possible. Due consideration is to be given to:-

a. Increasing cost of sites.

b. Environmental pressures.

c. Space limitations.

In the case of the environmental pressures, the overall height would be the most predominant problem due to increasing local planning regulations.

2.3 MODULAR DESIGN

A general philosophy of modular design is to be used in the overall system. This is considered to be mostly relevant in the following areas:

1. Aggregate storage.

2. Weighing equipment.

3. Control equipment.

4. Mixer design.

2.4 SAFETY

All parts of the system are to comply with the relevant provisions of the Health and Safety at Work Act and shall, in addition, comply with any legislation which may be in force in countries considered to have likely export potential.

Safety in the context of this specification shall be considered in its widest terms and shall include:-

1. Noise.

2. Dust.

3. Accident prevention (active).

4. Accident prevention (passive).

5. Electrical.

2.4.1 Noise

The levels of noise at any point within the plant shall be within the current statutory requirements of the industry to which the equipment is being supplied. In order to achieve this a noise reduction (modules) and these will be supplied as dictated by individual requirements.

2.4.2 Dust

The acceptable levels of dust will be dictated by the industry using the equipment, but the minimum standard shall at least comply with any statutory legislation applicable to general industry.

In order to achieve this a dust control system shall be designed which will give varying levels of control and these may be supplied to suit individual industries.

2.4.3 Accident Prevention (Active)

All moving parts of the equipment shall be guarded to the required standard. The guarding shall be so designed that no access to moving parts can be gained while the plant is in operation.

In certain applications the actual mix may be dangerous and in this case , access shall only be gained when the system is considered safe.

2.4.4 Accident Prevention (Passive)

The design of the system is where possible to give a good standard of passive accident prevention, that is, a good standard of lighting, suitable access to equipment, etc.

2.4.5 Electrical

The equipment shall comply with all current applicable U.K. and E.E.C. electrical standards.

2.5 FINISH

The protective treatment applied to the system is to be to a high standard and is to be suitable for a wide number of applications.

The external finishes of the equipment is to be specifically designed to blend in with its surroundings, the use of coated sheets are considered suitable.

2.6 CLEANING

The system shall be easy to clean, both internally and externally. This particularly applies to the mixing section and the internal parts of the batching system.

The basic principles shall be the reduction of crevices where the various mixing materials can collect, and the provision of easy access for cleaning.

2.7 VARIETY REDUCTION

In all parts of the system, a general principle of variety reduction shall be applied. This is not to be pursued at the cost of versatility, but the basic components should be sized to give as wide a usage as possible.

2.8 CONTROL

The overall control system should be designed on the most complex application and then the simpler versions derived from this. This will ensure the correct system being available for all applications. If commercially possible, this system should be obtained from one source.

2.9 STANDARDS

2.9.1 Metrication

All machinery and plant shall be designed and built using metric standards.

2.9.2 Specifications

All specifications and publications shall be to metric standards.

2.10 MAINTENANCE

The system shall be designed to require a minimum amount of maintenance and when required shall, if possible, be centralized and automatic.

2.10.1 Maintenance Periods

The maintenance periods shall be such that the requirements fit into a standard working pattern, i.e. once weekly. This allows for the work to be carried out in a period on none use.

2.10.2 Identification

The type and time intervals shall be clearly placarded on the machine together with a colour code system to identify maintenance points and type of attention required.

2.11 LABOUR REQUIREMENTS

The labour requirements for the normal operation of the plant shall be minimal and unskilled, or at most semi-skilled.

2.12 ENVIRONMENTAL

The system shall comply with all environmental conditions applicable to the industry in which the plant is to be used. These shall be in addition to those included in the remainder of this specification.

3.0 MIXING MACHINE

In consideration of the mixer the specification will be written around the requirements of a concrete mixing machine, but will include specific references to general and chemical mixing where considered appropriate. The specification is divided into three sections:-

a. Machine physical parameters.

b. Mix definitions.

c. Mixing parameters.

3.1 MACHINE PHYSICAL PARAMETERS

This section is again divided into a number of specific areas. These are given below.

1. Mixer section.

2. Power.

3. Structure.

4. Door.

5. Covers.

6. Control.

7. Air Seal.

8. Dust control.

9. Mix monitoring.

10. Additional services.

3.1.1 Mixer Section

3.1.1.1 Geometry

The geometry of the internal faces of the mixer section shall conform to those defined in the development phase of the machine. These dimensions will vary with the diameter and capacity of the individual machine.

3.1.1.2 Loadings

The mixing section is subjected to type types of loading:-

1) Dynamic loads applied by the mixing action, the loadings will vary depending upon the size and use of the machine, at this stage no definite values are known. Under normal conditions, the loads will be uniformly applied to the machine, but it has been noticed that large out of balance loads may be caused by the differential consistencies of the mix, these loadings should be taken into account when designing this section.

2) Statis or dynamic loadings caused by the addition or discharge of the mix consistencies.

The design cases should be the combination of the most critical loads found from 1 and 2 above.

3.1.1.3 Materials

The materials which contact the mix on the faces of the rotor and stator have widely differing properties.

1. Rotor

The rotor is to have the strength to withstand the loads applied from the mix (3.1.1.2), but must also have a suitably high coefficient of friction to impart the required drive off forces to the mix particles. It is envisaged that the friction material will be in the form of an easily removable disc fitted to the top face of the rotor, the material which has proved to be satisfactory in the trials to date is Linatex. The time taken to replace this material should be minimal and should not require complete dismantling of the machine.

2. Stator

The stator shall be made from a material which is capable of withstanding the forces applied from the mixing action and shall have a wear resistant surface and be easily manufactured to a good degree of surface finish.

A splitter bar is fitted to the stator, the material of this bar is to be similar to that of the stator, but shall have superior wear properties to those of the parent stator.

3.1.1.4 Life

The life between replacements of the rotor and stator would ideally be comparable with those of present mixing machines, but it is thought this would not be possible on the friction material. This would need renewing at more frequent intervals, but in any case would depend upon the types of materials being mixed.

The life of the splitter bar should be again comparable with that of present mixing equipment, but should be made simple to replace, possibly at the same service interval as the covering material.

3.1.1.5 Splitter Bar

The splitter bar is fitted to the statbr and removes the mix from the stator, the shape of the bar used to date has been a simple rectangular section, but it would seem that a modified profile may give a more effective suction breaking action. The bar could be moulded into the stator profile but this would depend upon the material and manufacturing process used. The possible attachment on to the door should also be considered.

3.1.2 Door

3.1.2.1 Geometry

The inside profile shall generally conform to that detailed in 3.1.1.1.

3.1.2.2 Operation

The operation of the door shall be such that all the moving faces will be self-cleaning, hence preventing the build up of the mixed material in any part of the operating mechanism. The door shall be capable of being operated by any of the normal methods of service, i.e. hydraulically, pneumatically or electrically.

The operating method shall be capable of being fitted with a device to monitor the doors correct operation. This may take the form of switches or any other form of suitable position indicator.

3.1.2.3 Seal

The door is to be proof against ingress of material from the outside of the mixer and egress of the mixed material from inside the bowl. The sealing system may be varied depending upon the type of mix and wearing properties required. In the case of concrete, the use of an air seal may be considered.

3.1.2.4 Maintenance

The maintenance required by the door shall be minimal and shall, if possible, be reduced to that of the overall mixing system. If the type of mixing to be carried out indicates the need for more frequent attention, then this shall, if possible, be automatic. If possible the use of oil shall be eliminated to prevent the contamination of the mixed materials.

3.1.2.5 Adjustment

The door shall be provided with sufficient adjustment to allow for initial fitment and subsequent adjustment when required in service. The in-service adjustment will be mainly to maintain the stator profile.

3.1.3 Structure

3.1.3.1 Loads

The loads applied to the main support structure will be originated from three main areas:-

a. Mixer Section

The loads from the mixer section will be applied to the main support structure from both the rotor and stator. The rotor loads will be initially absorbed into the drive system and hence to the base of the unit. The stator loads will be initially transmitted to the side walls and hence to the base unit.

b. Batching System

The loading from the batching system will be initially taken by the top of the mixer and hence transmitted to the base section. These loads it is thought will be of a limited magnitude and will mainly consist of interfacing loadings.

c. Mechanical Loadings

The mechanical loads will originate from mainly in the drive system and will be generated when the mixer is either mixing, loading, discharging or being started or stopped. All loadings generated should be considered, these will include shock, vibration fatigue, etc. In addition, to these loadings, the vibration and shock loadings from the door operating mechanism and batching system should also be considered.

3.1.3.2 Materials

The materials to be used in the main mixer structure shall be compatible with the loadings and strength requirements and shall be simple to manufacture by the sponsoring company, but this shall not preclude the development of new manufacturing techniques.

The materials shall be resistant to the chemicals normally expected in the area of concrete mixing, this shall also apply to materials closely associated with concrete, that is, materials used as admixtures or property modifiers.

3.1.3.3 Life

The life of the structure shall be compatible with that of present mixing equipment (10 years), this shall be without major repair, except in the case of accident damage. The calculation of fatigue life shall be calculated upon a duty cycle of 18 hours per day, 5 days per week of continuous running.

All parts of the structure shall have a comparible life profile.

3.1.4 Disc Drive System

The power system for the disc will be considered to be electrical. This will not preclude development of a version powered by other means. The speed difference between the disc and standard electric motors will necessitate some means of reduction, at this stage one of two methods are envisaged:-

a. Mechanical.

b. Hydaulic.

a. Mechanical

In the application as a concrete mixing machine, the use of a gear box is considered to be most suitable, and would be readily available in a variety of reductions and powers.

b. Hydraulic

In applications where variable speed or hazardous materials are being mixed, a form of hydraulic drive would be suitable. This would incur additional cost due to the need to provide a suitable power pack. This would be reduced if all the mixers were powered from a central ring main. In all cases, the power system shall meet the requirements laid down in the following chapters.

3.1.4.1 Geometry

The geometry of the drive chain shall be so designed as to give a minimum height to the overall mixing machine. This requirement shall be carried out with due regard to the requirements of Section 3.1.4.

3.1.4.2 Loadings

The drive system shall be capable of accepting the loads applied by the power requirements, but shall also be capable of withstanding the loads applied by the mix and the input and discharge sequence. The drive system shall also be capable of accepting any out of balance loads generated by the non symetrical loading or mixing of the ingredients.

3.1.4.3 Life

The expected life of the drive system shall be not less than three years at a nominal use of 12 hours per day, 5 days a week. This shall apply to both mechanical and hydraulic drive systems.

3.1.4.4 Power Requirements

The power requirements vary depending upon the overall batch output of the machine, but power requirements of the two machines envisaged at this time are given below.

a. Small machine (1000 mm dia)

The power required for a 0.14 m^3 batch is 11.69 kW.

b. Larger machine (2000 mm dia)

The power required for a 0.45 mm^3 batch is 23 kW.

3.1.4.5 Maintenance

The maintenance required on the power train shall be minimal and if possible none between major overhauls. The only acceptable operations are the checking and topping up of gearbox oil levels on the mechanical gearbox and the checking for oil leaks on the hydraulic system.

3.1.5 Covers

The covers on the machine may be subdivided into three sections:-

a. Motor unit covers.

b. Mixer section covers.

c. Inlet section covers.

The basic requirements for these covers shall be similar but will vary in their duties.

a. Motor Unit

The covers used around the motor unit shall protect the drive system and ancillary controls from damage either by physical means or by damage from the materials being mixed.

b. Mixer Section

The covers around the mixer section shall be to protect the door operating mechanism from damage and to prevent the ingress of the mix materials.

c. Inlet Sections

The covers around the inlet section of the mixer shall prevent the escape of dust and shall also provide limited support and alignment for the batching equipment.

3.1.5.1 Geometry

The geometry of the covers shall be determined by the design of the individual parts of the machine.

3.1.5.2 Loadings

The covers for the motor and mixing section shall carry no structural loads but shall be capable of withstanding loads associated with accidental local collisions.

The inlet section covers shall be capable of accepting limited local support loadings from the batching system, but these loads shall not in any case be taken directly by the covers but by their support structure.

3.1.5.3 Materials

The covers shall be made from suitable materials which will give the required properties, (see 3.1.3.2).

3.1.5.4 Life

The life of the covers shall be comparable with that of the overall mixing system.

3.1.5.5 Maintenance

Maintenance on the covers shall be minimal and shall be simple to carry out.

3.1.5.6 Removal

The covers shall all be simple to remove and shall not weigh more than is able to be handled by one man.

The motor and mixer section covers shall be considered to be removed at less frequent intervals than the inlet covers.

Typical removal rates shall be considered as once per month for motor and mixer section covers, and once per day for inlet covers. The more frequent removal rate for the inlet section is for the daily check on cleanliness of the inlet sections and the mixer itself.

The inlet section covers may be hinged or counter-balanced to allow for easy access.

An observation window should also be fitted in the inlet section to allow the mixing action to be viewed.

3.1.6 Control

The degree of control on the mixing machine will vary with the type of mixing and the allied batching plant. The control systems noted below those which would be used on the most sophisticated system.

3.1.6.1 Disc Speed

On machines with variable disc speed a means of controlling and sensing the disc speed should be available. The system chosen should interface with the control system used on the batching system. Depending upon the frequency of speed changing the method used may be either automatic or manual. It is also considered that some indication of the disc running should be given even on the simplest machine.

3.1.6.2 Door Position

The door control system shall have provision to be either locally controlled or controlled remotely. The system of control shall be compatible with the automatic systems used to control the batching sequence, a feed back of door position shall also be incorporated. That is, the provision of limit switches at each extremity of the door travel.

3.1.6.3 Air Supply

In order to prevent the mixing of materials without the air seal in operation, an interlock system shall be included to prevent the initiation of mixing or batching without the air seal being initiated. The detection system should also indicate a malfunction in the air seal, that is low pressure or no pressure, and should shut down the mixing operations should this fault occur.

3.1.6.4 Covers

To prevent accidents, the inlet covers are to be interlocked into the main mixing cycle, so that the opening of the covers would stop the mixing and batching action.

3.1.6.5 Power Monitoring

To assess the physical properties of the mix, an accurate readout of the power being used by the mixing machine is required. This again should be in the form which would allow the data to be processed automatically by the master control system.

3.1.7 Air Seal

3.1.7.1 Geometry

The geometry of the air seal will probably vary with individual applications of the mixer. The seal used in the prototype machine was a simple slot, but it is thought that a more complicated seal shape may reduce the volume and pressure of air required.

3.1.7.2 Pressure

The pressure used in the air seal is to be a maximum of 172 kN/m^2 should be reduced where possible.

3.1.7.3 Volume

The volume of air required is presently thought to be a minimum of

0.11 m^3/s per m of air gap.

3.1.7.4 Air Source

The source of air seal is not critical but the most economical would appear to be a small rotary compressor mounted below the mixer unit.

3.1.7.5 Life

The expected life of the air generation system shall be comparable with that of the power chain, three years at a nominal use of 12 hours per day, 5 days a week.

3.1.8 Pollution Control

With the use of the air seal, the dust produced will be more pronounced and a positive form of control will be necessary. Two methods are thought to be practical at this time. The first is to spray the mix water into the mixing section at the same time as the introduction of the other mix ingredients, hence reducing the dust, this would be simple in the production of concrete. In the case of other mixing applications, a form of dust extraction system using filters is envisaged.

Little definite data is known at this stage on the extent of the problem, and this part of the specification will be amended as more data becomes available.

3.1.9 Mix Monitoring

When the mixing is taking place it would be desirable to monitor certain basic parameters of the mix. These may be divided into two areas, those needed for concrete, and those needed for chemical mixing.

3.1.9.1 Concrete

a. Water Content Measurement

It shall be possible to incorporate any of the presently available water content measuring and control equipment.

b. Workability Measurement

The machine shall be capable of monitoring the relative workability of the mix, this may be carried out by monitoring the power input to the mixing machine.

3.1.9.2 Chemical

At this stage exact type of mix monitoring is not known, but any one or all of the following should be considered.

1. Pressure.

2. Temperature.

3. Vacuum.

4. Liquid content.

5. Workability.

3.1.10 Additional Services

In order to achieve certain chemical changes, or to speed reactions, additional services may be required.

3.1.10.1 Concrete

The additional services required when mixing concrete are at present limited.

a. Steam

In order to obtain quicker initial set times, steam is injected into the concrete when mixing, this increases the temperature of the mix, hence reducing the setting time, the mixer shall be able to be simply adapted to the use of steam. This could be introduced either through the stator with suitable perforations, or it may replace the air in the air seal.

b. Heat

As a replacement for steam which has the disadvantage that a certain proportion of the mix water must be omitted to allow for the steam condensation, hence causing a quality control problem, may be the introduction of direct heat again this is possible through the stator.

3.1.10.2 Chemical

The additional services required in the chemical sphere of mixing may be many, but the main areas are:-

1. Pressure.
2. Temperature.
3. Vacuum.
4. Liquid addition.
5. Workability.
6. Mixing in an inert atmosphere.
7. Mixing in a gas atmosphere.

All the above services should be considered when designing the overall mixing system.

3.2 MIX DEFINITIONS

The definitions of the mix may be divided into two main areas:-

a. Types of mix.
b. Quality of mix.

3.2.1 Types of Mix

The types of mix may again be divided into two sections:-

3.2.1.1 Existing Types

The machine shall be able to mix all present types of concrete, these range from the low sump stiff concretes, mainly used in the manufacture of concrete products, to the high slump mixer more commonly met in the ready mixed industry.

The mixing action shall be effective with all cement types and aggregate combinations.

3.2.1.2 New Types of Mix

The machine shall be capable of mixing the newer types of concrete, the main examples of these being:-

a. Polymer

The mixer shall be capable of mixing this type of concrete, the introduction of the polymer should be achieved by a purpose designed dispensation system, this would allow the maximum economy of the active ingredients, hence reducing the cost per meter.

b. Fibre

Steel

The machine should be capable of mixing steel fibre concrete as an integral part of the design. A device for the introduction of the steel fibre should be available, this could either be in the form of a boxed wire dispenser, or more likely a wire strand chopper and former.

Glass

The machine should be capable of mixing glass fibre concrete, a glass fibre introduction system should be an integral part of the mixer.

c. Plasticiser

The machine shall be capable of mixing super plasticised concrete as a part of the mixing system. A precision method of dispensing the plasticiser should be available.

d. Lightweight

The machine shall be capable of mixing all types of lightweight concrete, the system shall be able to cope with the more fragile types of aggregate and shall include facilities for soaking this type of aggregate.

e. Plastic Materials

The machine shall be capable of mixing satisfactorily this type of concrete without damage to the foamed or similar aggregates.

3.2.1.3 Mix Types Chemical

The machine shall be capable of mixing suitable chemical materials, these materials are as yet undefined but should be assumed to be of similar size to that of concrete, that is, from 10 μm to more than 100 mm. This covers the major range of chemical products. The consistencies of the products will vary from fine dry powders to materials with a consistency similar to that of concrete.

3.2.2 Mix Quality

3.2.2.1 Mixedness

This may be judged by the British Standard 3969 : 1974, but with suitable modifications, as indicated by the previously carried out test work. The basic criteria for assessment in this standard are:-

1. Aggregate distribution.
2. Cement distribution.
3. Water distribution.

3.2.2.2 Compressive Strength

The machine shall produce consistently concrete of the maximum compressive strength for a given cement content. This would thus allow a cost saving on cement content, particularly if the variation in strength results can be reduced, hence allowing for better quality control.

3.2.2.3 Aggregate Damage

The mixing action should minimise the damage to the gripping faces of the aggregate, thus giving a higher strength and allowing a lower cement content for a given strength.

3.2.2.4 Workability

The machine shall produce a concrete of consistent workability with due consideration to the variation of the constituent ingredients.

3.2.3 Mix Quality Chemical

At present the criteria for each individual application will have to be considered separately, as in this field the basic requirements vary so widely.

3.3 MIXING PARAMETERS

In order to complete the specification on the mixer section, it is necessary to define certain boundary conditions. These are defined in the following sections.

3.3.1 Speed of Mixing

The speed of mixing shall be as fast as is consistent with a well mixed material. The speed shall not cause undue wear on the part of the machine used for mixing, i.e. blades, bowl, etc., or damage to the material being mixed.

3.3.2 Time of Mixing

The time of mixing, which is the length of time which the mix is actually in the mixing machine, shall be as short as possible, but shall not be more than 30 seconds.* (This time is the minimum quoted by the larger mixer manufacturers.)

NOTE: * This assumes comparable mixes.

3.3.3 Power Required

The power required should be a minimum for four main reasons.

a. The actual cost of running the plant would be reduced if the size of motors used was decreased.

b. The damage done to the machine (wear) is proportional to the amount of energy imparted to the mix and again if this is minimised per unit volume of concrete the running costs will be reduced.

c. The amount of energy used in the mixing action can be detrimental to to the mix itself. It can cause heating within the mix, but more important in concrete the bonding surfaces of the aggregate may be worn, hence reducing the overall compressive strength.

d. Machine size and cost can be reduced if the energy requirement is reduced relative to output, i.e. kWh/m^3.

3.3.4 Cleanliness of Discharge

The machine shall discharge its batch with a minimum amount of residual material being left in the mixing machine. The most important point is that a residual build-up should not occur.

3.3.5 Rate of Discharge

The rate of discharge shall be as high as possible, but giving due consideration to the effects of segregation due to forces imparted due to the discharge method used, i.e. large drops to containers or high acceleration.

3.3.6 Charging Sequence

The charging sequence of the mix ingredients shall not be critical but if the sequence is critical, then the sequence shall be possible to control automatically.

3.3.7 Consistency of Mixing

The machine shall produce a consistent mix between and within batches. This consistency shall be measured using the approved British Standard (B.S. 3963) : 1974).

(NOTE: The recommended modifications to this specification are noted in the appropriate section of the thesis.)

4.0 BATCHING SYSTEM

In considering this part of the system, the specification is written only in general terms. This is due to the limited amount of investigation carried out in the project. This was limited to the overall determination that the control and weighing of the mix ingredients was possible at the increased speeds needed for the rotary mixing machine.

The specification is arranged under the following headings:-

1. Material storage.
2. Feeding methods.
3. Proportioning.
4. Control.

4.1 MATERIAL STORAGE

In the storage of the component parts of the mix the type of equipment is often dictated by the needs of a particular installation. The choice of overhead or ground storage or a combination of both will be determined by the availability of the materials and hence the need to store large quantities the space available and the plant output. In order to allow for these possible variations in storage, a modular system of units is considered essential.

The sections of the specification apply equally to both overhead and ground storage systems, and to the storage of cement and mix water.

4.1.1 Capacity

The capacity of the storage system is to be such that the mixing system may be used at its maximum rated output without the need for critical delivery schedules. In addition, sufficient additional storage shall be available to cope with any reasonable delays in delivery.

4.1.2 Geometry

The geometry of the storage system shall be such that flow characteristics of the materials shall be suited to the discharge control method used. The storage system should have as low a profile as practicable in order to minimise the predicted problems appertaining to local planning permission.

4.1.3 Loads

The loads applied to the structure shall be determined both from the current structural requirements and from the loadings imposed from the equipment used for batching etc. If vibratory feeders are used, particular note should be taken of the possible fatigue effects induced.

4.1.4 Material

The storage system shall be made from materials which have the properties to withstand the defined loadings, particular reference shall be made to the ability of the outside finish to blend in with its surroundings, this is to minimise the impact on the local environment.

4.1.5 Life

The life of the storage system shall be comparable with those made at present, approximately ten years.

4.2 FEEDING METHODS

The feeding methods used for each of the input materials will probably be different, due to the properties of the materials being fed, the constituents being:-

1. Aggregates.
2. Cement.
3. Water.
4. Additional.

4.2.1 Aggregates

4.2.1.1 Types of Aggregate

The feeding system shall be suitable for all currently used types of aggregates. These are to include the newer special aggregates, such as lightweight.

4.2.1.2 Speed of Feeding

The required feeding speed shall be determined by the overall plant requirements, but a maximum of 100 kg/sec will give the most critical feeding rate.

4.2.1.3 Damage to Aggregate

The damage caused to the aggregate by the feeding system shall be negligible.

4.2.1.4 Control

The control of the feeding system shall be such as to match the reaction time of the control system, and hence give an acceptable degree of overall accuracy.

4.2.2 Cement

4.2.2.1 Types of Cement

The cement feeding system shall be suitable for all currently available types of cement.

In addition to the cements, the cement reducing agents shall also be satisfactorily fed by the system.

4.2.2.2 Speed of Feeding

The required feeding speed shall be determined by the overall plant requirements, but a maximum of 30 kg/sec will give the most critical feeding rate.

4.2.2.3 Control

The control of the feeding system shall be such as to match the reaction time of the overall control system, and hence give an acceptable degree of overall accuracy.

4.2.3 Water

4.2.3.1 Speed of Feeding

The required feeding speed shall be determined by the overall plant requirements, but a maximum of 15 litres/sec will give the most critical feeding rate.

4.2.3.2 Control

The control of the feeding system shall be such as to match the raction time of the overall control system an acceptable degree of overall accuracy.

4.2.4 Additional Feeding Requirements

In order to be able to mix the newer and more difficult mixes, new feeding requirements have been found to be necessary. No definite information is at present available, but a note of each area is given below.

1. Glass fibre.
2. Steel fibre.
3. Admixtures.

4.2.4.1 Glass Fibre

A feeding system is required to feed into the mix a definite quantity of chopped fibre glass.

4.2.4.2 Steel Fibre

A feeding system is required to feed into the mix a definite quantity of chopped steel fibre.

4.2.4.3 Admixtures

A feeding system is required to feed into the mix a definite quantity of any admixture.

4.3 PROPORTIONING

To produce a viable product, each of the constituents of the material being mixed must be added to the mixer in the required proportions. The most accurate method of achieving this is to weigh each ingredient.

4.3.1 Capacity

The capacity of the weighing system shall be compatible with the feeding, mixing and control of the system.

The capacity shall be determined for each individual mixing capacity but this shall not preclude the use of a single capacity system if the cost penalty is acceptable.

4.3.2 Speed

The speed of operation of the weighing system shall be compatible with the designed mixing speed (20 seconds/batch).

This indicates an individual weigh hopper for each ingredient with a 10 - 15 sec batch, weigh and check times. This shall, however, not preclude the use of a combined system if the required time cycle can be achieved.

4.3.3 Accuracy

The accuracy of the weighing system shall be as good as is compatible with the overall system, but shall provide a final mix accuracy at least as good as the present system.

4.3.4 Life

The life of the weighing system shall be at least that of the general plant.

4.4 CONTROL

The control system will be closely allied to the feeding and weighing systems and will, in effect, determine the types and accuracy of this equipment.

4.4.1 Philosophy

The philosophy of the overall system is that the control system should be designed to give the most sophisticated type likely, and then extract the lower grades of control from this system.

4.4.2 Degrees of Control

The degrees of control shall be:-

a. Complete computer control.

b. Limited computer.

c. Automatic control.

d. Limited automatic control.

e. Manual control.

a. Complete Computer Control

This system would give computer control of the following functions:

1. Weighing and batching equipment.
2. Mixing machine including washout.
3. Quality control of mix including update facility from cube test results.
4. Quality control of wet concrete.
   a. Water content.
   b. Slump.
5. Production of certified content documentation.
6. Invoicing and accounting.
7. Stock control.
8. Ordering of new material.

9. Automatic weigh checking.

10. Total quality control programme.

b. Limited Computer Control

This system would omit the invoicing and stock control functions from (a).

c. Automatic Control

This system would omit the quality control functions, and would have a modified mix input system.

c. Limited Automatic Control

The system compares with that presently available and would only include automatic weighing.

e. Manual Control

This system is not a really reliable one for the rotary mixer due to its speed of operation, but may be used with the larger type of mixer when fitted to existing equipment.

4.4.3 Interlocks

The control system shall be so designed as to allow the simple introduction of required interlocks between feeding, weighing and mixing cycles so as to prevent the production of incorrect mixes.

4.4.4 Life

The life of the control system shall be comparable with that of the basic mixing system.

4.4.5 Environment

The control system shall be unaffected by the adverse environment encountered in this type of equipment.

APPENDIX

K

MARKETABLE MIXER SIZE

APPENDIX K

DETERMINATION OF MARKETABLE MIXER SIZE

1.0 OUTPUTS AVAILABLE

The first stage in the determination of a marketable mixer size was to compile a table of the outputs at present available from mixers of certain capacities and using a series of cycle times. This table is shown in K.1.

CAPACITY		CYCLE TIME (S)					
LITRE mixed concrete	kg	20	30	40	50	60	90
11	25	1.9	1.3	1.0	0.8	0.6	0.4
21	50	3.8	2.6	1.9	1.5	1.3	0.9
42	100	7.7	5.1	3.8	3.1	2.6	1.7
64	150	11.5	7.7	5.8	4.6	3.8	2.6
85	200	15.3	10.2	7.7	6.1	5.1	3.4
106	250	19.2	12.8	9.6	7.7	6.1	5.1
212	500	38.3	25.5	19.1	15.3	12.8	8.5
319	750	57.4	38.3	28.7	23.0	19.1	12.8
425	1000	76.6	51.1	38.3	30.6	25.5	17.0
532	1250	95.7	63.8	47.9	38.3	31.9	21.3
638	1500	114.9	76.6	57.4	46.0	38.3	25.5
1276	3000	229.0	153.0	115.0	92.0	77.0	51.0

All outputs m^3/h

Table K1

This table gives a general indication of the possible outputs available from a specific size of mixing machine. (NOTE: capacity in litres of mixed concrete, multiply by 1.5 to be compatible with Table K.2.)

2.0 MARKETABLE SIZE

2.1 MARKET DATA (LINER AND TEKA)

To determine the most marketable size of mixing plant, based on the data at present available, a review of the sales data available from Liner and Teka was undertaken.

		RP200	RP400	RP550	RP850	RP1250	RP1500	RP3000	
	cap. litres unmixed concrete	184	400	566	850	1250	1500	3000	
	number sold	92	211	103	172	37	34	1	
	%	14	32	16	26	6	5	1	
	cum %	14	46	62	88	94	99	100	
cycles /hour	60	7.5	16.5	24	36	51	60		output mixed concrete m^3/h
	50	6.25	13.75	20	30	42.5	50		
	40	5	11.0	16	24	34	40	80	

Table K2

2.1.1 Liner

The sales data available from Liner is shown in Table K2. As can be seen from these figures, the main sales for the Liner mixers are up to the RP 850, this gives outputs of 36, 30 and 24 m^3/h for cycle times of 60, 50 and 40 batches per hour respectively. It should also be noted that 99% of Liner sales are under 1500 litres. (The RP 3000 machine has only been on the market for a short time.)

2.1.2 Teka

An additional input to the available data was that published by the manufacturers of Teka mixers in their publicity literature. This information details sales in the U.K. over a comparable length of time to that available from Liner. This information is shown in Table K3. The data was sufficiently detailed to allow the pattern of sales to be studied, this indicated that the larger mixing machines were predominantly sold to the manufacturers of ready mix concrete. In order to provide more directly comparable figures, the mixers supplied to these companies were deducted from the total, the modified data is shown in Table K4.

It again may be noted from this table that 83% of the sales are covered by the machines up to 1500 litres capacity.

	cap. litres	375	500	750	1000	1125	1500	1875	2250	3000	4500
	number sold	2	21	10	2	15	23	-	14	13	1
	%	2	21	10	2	15	23	-	14	13	1
	cum %	2	23	33	35	50	73	-	87	100	-
cycles /hour	60	15.25	21	31	-	46	60				
	50	13	17	25	-	38	50	65			
	40	10	14	21	-	31	40	52	61	80	120

Table K3

cap. litres	375	500	750	1000	1125	1500	1875	2250	3000	3750	4500	
number sold	2	21	10	2	15	23	-	10	5	0	9	88
%	2	24	12	2	17	26	-	11	6	0	0	
acc %	2	26	38	40	57	83	-	94	100	-	-	

Table K4

2.2 MARKET SURVEY

The market survey results indicate that for concrete products, mixer sizes up to 1500 litres (60 m^3/hour output) account for 80% of sales. From the contractors survey 97% of mixer sales are below 1500 litres. In addition, the fact that 80% of site mixers are of 500 litres or less, i.e. below 6.34 m^3/hour.

2.3 RELATIVE OUTPUTS

The mixers in the range of outputs up to 60 m^3/hour cover the greatest part of the sales, in fact, these account for 99% of Liner sales and some 83% of Teka sales. This trend is also borne out by the results of the postal survey which showed that 80% of mixer used are below an out of 60 m^3/hour. The majority of the remaining part of the market is covered by mixers up to 90 m^3/hour output.

In the smaller mixer range, over 60% of the machines sold by Liner are in the range of outputs up to 24 m^3/hour, and approximately 33% of the Teka mixers are in this range. 80% of site mixers are covered by outputs of 0.34 m^3/batch (20 m^3/hour), this again fits in with the requirements in the other sphere of operation.

2.4 RELATIVE SIZES

The size concept of the new range of mixers is that the new machine should be of a size which is the same or smaller than that are present available. By analysing the data available in the mixer survey section, the minimum dimensions for a 1500 litre input mixer were shown to be a diameter of 2.5 m x 1.05 m high. In considering the smaller machines up to 500 litres input, the minimum dimensions were 1.9 m diameter x 1.035 m high.

2.5 DESIGN REQUIREMENTS

2.5.1 Small Mixer

Output up to 24 m^3/hour. Size 1.9 m diameter x 1.035 m high.

2.5.2 Large Mixer

Output up to 60 m^3/hour. Size 2.5 m diameter x 1.05 m high.

APPENDIX

L

DESIGN CALCULATIONS

APPENDIX L

DESIGN CALCULATIONS

1.0 DESIGN

The largest machine design found to mix satisfactorily is that with an overall stator diameter of 0.732 m (2'Z'in L.1). The machine has a stator radius of 0.152 m (r in Fig.43) and a maximum mix capacity of 176 kg, thus giving a maximum hourly output of 13.5 m^3/hour for a 20 second batch time and 6.7 m^3/hour for a 40 second batch cycle time. This compares with the company's RP 400 mixing machine running at 50 cycles per hour. (See Table K2).

The required output for the smaller mixer is 24 m^3/hour (Section K 2.5.1). From Section 8.18 the volume model for a machine having a 0.152 stator radius was found to be:-

$$V = 0.13 + 0.146\ D$$

In this case $V = \dfrac{24}{60 \times 3} = 0.133\ m^3$/batch

based on a 20 second cycle time.

$$D = \frac{0.133 - 0.013}{0.146} = 0.82\ m$$

But $D = D_T - 2 \times r$

$$D_T = D + 2 \times r$$

$$= 0.82 + 2 \times 0.152$$

$$\underline{D_T = 1.124\ m}$$

As the stator radius 'r' has been increased from the initial 0.127 m to 0.152 m with apparently no reduction in the mixing action, it would seem reasonable that the radius could be increased by a further 0.026 m to 0.178 m. Again, using the volume model from Section 8.18 for a 0.178 m stator radius.

$$V = 0.021 + 0.201\,D$$

$$D = \frac{0.133 - 0.021}{0.201}$$

$$\underline{D = 0.56 \text{ m}}$$

but $D_T = D + 2 \times r$

$$= 0.56 + 2 \times 0.178$$

$$\underline{D_T = 0.916 \text{ m}}$$

It would seem acceptable that if the rotor diameter was increased as well as that for 'r' as suggested above, the possibility of interference from the mix overlapping, as noted in Phase 3, would be non-existent. This mainly depends upon the relationship between the stator radius r and the stator diameter D. That is as the ratio $D_T : 4 \times r = 1$ then the upper boundaries become critical, in this case the ratio = 0.916/0.712 = 1.28 hence it is probable that the mixing action will function. (Section 8.27).

The logical size for a production mixer would be a stator diameter of 1.0 m. The actual volume would be greater than that in the above calculations, it is also conceivable that the machine would be sold with different size stators to give the required output. The possible capacities and outputs are shown in Table L.1, the value shown are maxima but as the mixer minimum capacity is approximately 50% of the batch, the range of capacities more than covers that required.

In considering the specified output of 24 m^3/hour the 1.0 m mixer with a 0.178 m radius stator will produce this in a batch cycle time of 23 seconds.

This is acceptable and with the wide capacity range this mixing machine would provide a useful development tool for production machines.

	D = 0.746	D = 0.696	D = 0.644
	r + 0.127	r = 0.152	r = 0.178
	V = 0.0079 + 0.104 D V = .083 m^3	V = 0.013 + 0.146 D V = .114 m^3	V = 0.021 + 0.201 D V = .15 m^3
	output/hour (m^3)		
output/ batch	.083	.114	.15
180 batch/hr	15.0	20.5	27
120 batch/hr	10.0	13.7	18
90 batch/hr	7.5	10.25	13.5

Table L.1

2.0 LARGER MACHINES

In considering the larger machine the required maximum output is 60 m^3/hour (Section K.2.5.2), and so similar reasoning may be applied to the sizing of the machine.

From Section 8.18 the volume models for each stator size up to 0.178 m radius and in addition a new formula for a 0.203 m stator radius was derived. If 180 batches/hour are taken as the normal rate, then the capacity of the mixer must be:-

$$V = \frac{60}{180} = 0.33 \ m^3$$

Again, as stated in Section 1 it would not seem unreasonable to increase the stator radius to 0.203 m an increase of 0.025 m.

The diameters needed to give a capacity of 0.33 m^3/batch for each stator radius is calculated in Table L.2.

The design parameters in Section K.2.5.2 give a maximum physical diameter of the smaller mixer of 1.9 m, it seems that the larger mixer could also be below this size if the 0.203 m radius stator was used.

r = 0.127	r = 0.152	r = 0.178	r = 0.203
V = 0.0079+0.104 D D = 3.168 + 0.254 D_T = 3.422 m	V = 0.013+0.146 D D = 2.171 + 0.305 D_T = 2.476 m	V = 0.024+0.201 D D = 1.550 + 0.356 D_T = 1.905 m	V = 0.032+0.26 D D = 1.148 + 0.407 D_T = 1.555 m

Table L.2

But as the use of an 0.203 radius stator has not been proved, then use of a 0.178 m radius would be prudent. Table L.3 gives the possible outputs of a machine with a 1.9 m stator diameter using the various stator radius sizes.

From this table it is noted that the 1.9 m stator will meet the design requirements and if a 0.203 m stator radius is feasible it will exceed them.

There would seem to be no reason why the use of an 0.203 m radius should not mix, as in Section 1, the critical ratio D_T : 4 r is equal to 1.9 / 4 x 0.203 = 2.34

∴ no mix overlapping problems should occur.

		D = 1.650	D = 1.600	D = 1.550	D = 1.400
		r = 0.127	r = 0.152	r = 0.178	r = 0.203
		V = 0.0079+0.104D V = 0.18 m^3	V = 0.013+0.146D V = 0.25 m^3	V = 0.021+0.201D V = 0.33 m^3	V = 0.032+0.26D V = 0.42 m^3
		output/hour m^3			
batches/hr.	180	32.4	45	59.4	75.6
	120	21.6	30	39.6	50.4
	90	16.2	22.5	29.7	37.8

Table L.3

3.0 Design Sizes

In order to allow a certain amount of latitude in the development of the 0.203 radius stator and to obtain a standard size stator the increase of diameter to 2.0 m is used.

3.1 Small Mixer

Stator diameter = 1.0 m.

Maximum output = 27 m^3 at 180 batches/hour.

3.2 Large Mixer

Stator diameter = 2.0 m.

The outputs possible are shown in Table L.4.

	D = 1.75	D = 1.69	D = 1.65	D = 1.59
	r = 0.127	r = 0.152	r = 0.178	r = 0.203
	V = 0.19	V = 0.26	V = 0.35	V = 0.45
180	34.2	46.8	63	81
120	22.8	31.2	42	54
90	17.1	23.4	31.5	40.5

All outputs in m^3/h

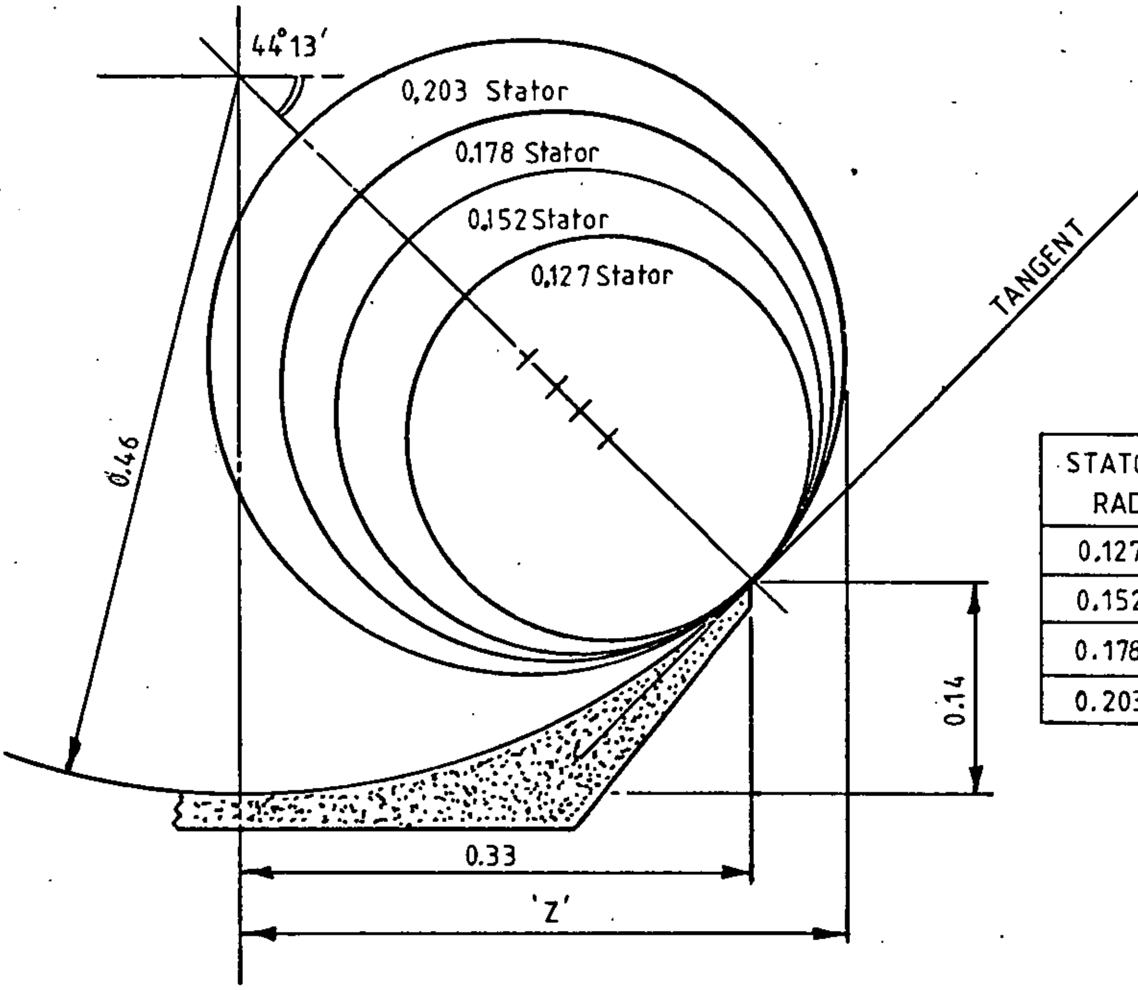
Table L.4

4.0 DESIGN OF 1.0 m DIAMETER MIXER

The design of this mixer is based upon the prototype bowl shape but using an increased diameter bowl. This increase will be achieved by adding a portion of flat to the centre of the disc. This gives the same rotor shape to each stator size, some common dimensions are given in Fig. L.1. The data shown in this figure give the rotor stator configeration for all the mixers considered in these calculations.

4.1 1.0 m MIXER (DIMENSIONS)

As an initial pre-production machine a 0.152 radius stator is considered to be a good compromise, it in effect allows the mixer diameter to be increased without moving totally away from known ground, i.e. 0.152 stator. Due consideration should be given to increasing the stator radius



STATOR RAD	DIMENSION Z
0.127	0.366
0.152	0.373
0.178	0.380
0.203	0.388

Fig. L.1

to the planned 0.178 at a later date, as may be seen from the table in Fig. L.1, the overall difference in mixer diameter from a 0.152 to a 0.178 stator is smaller by 0.007 m.

4.1.1 Actual Dimensions of 1.0m Mixer

The flat implant required at the centre of the disc for the mixer will be considered the same for both stator radii and that required for the 0.178 stator will be used for both, giving a slight oversizing for the 0.152 stator. The dimensions are shown in Fig. L.2.

$y = 0.50 - 0.38$
$= 0.12$

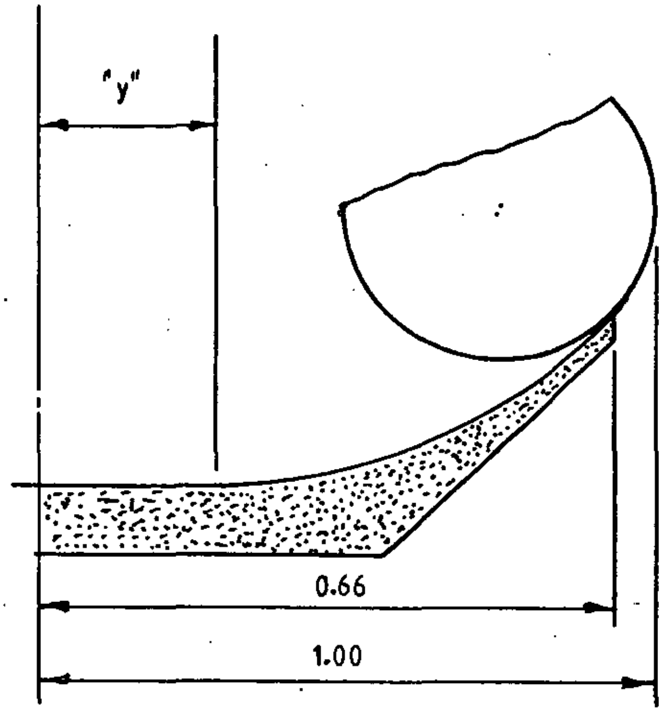


Fig. L.2

∴ overall disc diameter = 2 (0.33 + 0.12) = 0.90 m

4.1.2 Power

The power required by this mixing machine may be estimated using the stage 3 mathematical model.

The model is of the form.

$$\text{Input power} = W \mu_S \left[\omega_R^3 R^2 + 39.5\, n^3 r^2 (\gamma + \Omega) \right] + Wghn$$

where W = 0.15 x 2350 = 352 kg

g = 9.81 m/s^2

μ_S = .464

ω_R, n, R_R, & h are to be determined.

ω_R

The tip speed at the disc was 6.05 m/sec on the prototype machine and it is considered that at this stage this speed should be retained.

∴ q for 0.90 dia rotor (See 4.1.1)

$$q = \frac{6.05 \times 60 \times 2}{2\pi \times 0.090} = 128 \text{ rpm}$$

In considering the choice of drive arrangement for the mixer range, it is considered that the most reliable and compact system (certainly for the pre-production units) would be a gear-box. The radicon type of gear-box would give a shaft speed of 150 rpm using a standard 1500 rpm electric motor. This would give an increase in disc speed of:-

$$\text{Tip speed} = \frac{150 \times 2\pi \times 0.90}{60 \times 2} = 7.07 \text{ m/s}$$

relative to 0.66m disc

$$\therefore q = \frac{V_e\, 60}{2\pi r} = \frac{7.07 \times 60}{2\pi \times 0.33} = 205 \text{ rpm}$$

From the test results and considering the ultimate move to a 0.178 stator radius this increase in speed would at worst increase the necessary power used but would probably give the increased drive required to mix with a 0.178 stator. The speed could be reduced in the case of the 0.152 stator by the fitting of a 1200 rpm motor, thus giving a shaft speed of 120 rpm.

$$\therefore \omega = \frac{7.07}{0.45} = 15.7 \text{ rad/s}$$

$$\omega_R = 15.7 \times .37 \text{ rad/s} \quad \text{(See Table 17)}$$

$$\omega_R = 5.81 \text{ rad/s}$$

$$n = \sqrt[3]{5.81}$$

$$n = 1.80 \text{ rev/s}$$

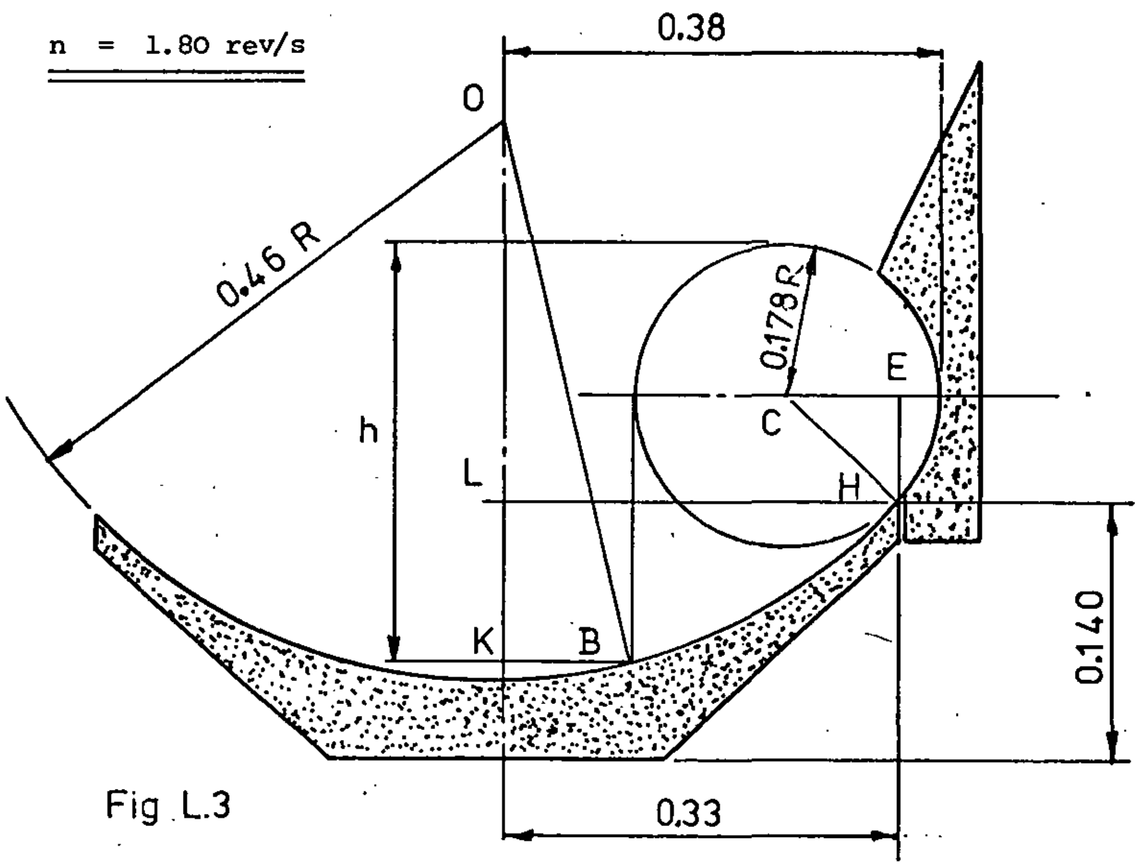


Fig L.3

To consider R_R

From equation (2)

$$R_R = \cos\psi\left[r \cdot \frac{\sin\left(\frac{\Omega+\gamma}{2}\right)}{\frac{\Omega+\gamma}{2}}\right] + \frac{D}{2}\ m$$

angle Ω = 20.9 (0.365 rad) (From Section 8.25)

angle γ = 44.21 (0.770) From Fig. L.1)

$D = D_T - 2r$

$D = 1000 - 2 \times .178$

$D = 0.644$

$$\psi = \gamma - \left(\frac{\Omega+\gamma}{2}\right)$$

$$= 44.21 \left(\frac{20.9 + 44.21}{2}\right)$$

$$\psi = 11.66^\circ$$

$$\therefore\ R_R = \cos 11.66\left[0.178\ \frac{\sin 32.56}{0.57}\right] + \frac{0.644}{2}\ m$$

$$R_R = 0.487\ m$$

$CE = 0.33 - (0.38 - 0.178) = 0.13$

$EH = \sqrt{0.178^2 - 0.13^2} = 0.122$

length $KB = 0.38 - 0.178 - 0.178 = 0.024$

$OK = \sqrt{0.46^2 - 0.024^2} = 0.459$

$\therefore\ AL = 0.459 - 0.321 = 0.138$

$\therefore\ h = 0.138 + 0.122 + 0.178$

$\therefore\ h = 0.438$

$\therefore$ Power required may be calculated by the use of equation (7).

$$\text{Input power} = W.\mu_S.\left[w_R^{\,3}.R_R^{\,2} + 39.5.n^3.r^2\ (\Omega+\gamma)\right] + W.g.h.n.$$

$$= 352 \times 0.464\left[5.81^3 \times 0.487^2 + 39.5 \times 1.8^3 \times 0.178^2\ (1.135)\right]$$

$$+\ 352 \times 9.81 \times 0.441 \times 1.8$$

$$= 8.95 + 2.74$$

Input power = 11.69 kW

By using this power requirement as a suitable starting point, we may now select a suitable gear-box motor combination.

Using the method suggested in the gear-box manufacturers catalogue

Basic Requirements

1.	Input rpm	1500
2.	Output rpm	150
3.	Hours running	8
4.	Shock conditions factor	0.9
5.	Power required	= 11.69 kW

Modified output = 11.69 x 0.9

= 10.52 kW

$$\text{Output torque} = \frac{10.52 \times 9545}{150} = 670\ \text{Nm}$$

To check the gear-box tables a suitable unit would be a 1250 which is rated at 15 kW and a torque of 881 Nm.

5.0 DESIGN OF 2.0 m DIAMETER MIXER

The same rotor stator interface geometry will be used and again a portion of flat will be used in the centre.

The machine will be designed with a 0.203 stator radius giving a batch size of (.45 m^3).

5.1 ACTUAL DIMENSIONS OF 2.0 m MIXER

The flat implant required at the centre of the disc for the mixer

length of flat = 1.0 - 0.388

= 0.612

∴ overall disc diameter = (0.33 x 2) + (0.612 x 2) = 1.884 m

5.2 POWER

The power required by this mixing machine may be estimated using Stage 3 mathematical model.

$$\text{Input power} = V \mu_S \left[w_R^3 R_R^2 = 39.5\, n^3 r^2 (\Omega + \gamma) \right] + Wghn$$

where $W = 0.45 \times 2350 = 1057$ kg

$g = 9.81\ \text{m/s}^2$

$\mu_S = .464$

w_R, n, R_R & h are to be determined.

w_R

The tip speed at the disc was 6.05 m/s on the prototype machine and it is considered that at this stage this speed should be retained.

q for 1.884 dia will be

$$q = \frac{6.05 \times 60 \times 2}{2\pi \times 1.884} = 61.2 \text{ rpm}$$

In checking the gear-box manufacturers tables the maximum power was at 1000 rpm input speed, the output speed of 66.67 rpm giving 23.9 kW at 3300 Nm. By using the above gear-box the tip speed will be increased:

$$V_1 = \frac{66.67 \times 2\pi \times 1.884}{60 \times 2} = 6.577 \text{ m/s}$$

∴ relative to 0.66 disc

$$q = \frac{V \times 60}{2\pi r} = \frac{6.577 \times 60}{2\pi \times 0.33} = 190 \text{ rpm}$$

The same logic as was used on the smaller mixer would apply

$$w = \frac{6.577}{0.94} = 7.0 \text{ rad/sec}$$

$$w_R = 7 \times .37$$

$$\underline{w_R = 2.59}$$

$$n = \sqrt[3]{2.59}$$

$$\underline{n = 1.37}$$

To consider R_R

From equation (2).

$$R_R = \cos\phi \left[r . \frac{\sin\left(\frac{\Omega + \gamma}{2}\right)}{\frac{\Omega + \gamma}{2}} \right] + \frac{D}{2}$$

All values except r and D will be as 1000 mm mixer.

$$D = D_T - 2r$$

$$= 2.0 - 2 \times 0.203$$

$$D = 1.594$$

$$r = 0.203$$

$$R_R = \cos 11.66 \left[0.203 . \frac{\sin 32.56}{0.57} \right] + \frac{1.594}{2}$$

$$\underline{R_R = 0.945 \text{ m}}$$

To calculate the value of h using diagram from small mixer

$$CE = 0.33 - (0.388 - 0.203) = 0.145$$

$$EH = \sqrt{0.203^2 - 0.145^2} = 0.142$$

Length KB = 0.388 - 0.406 = 0.018

∴ KB = 0.46 = OA

AL = 0.46 - 0.321 = 0.139

∴ h = 0.139 + 0.142 + 0.203 = 0.484

The power may again be calculated by the use of equation (7).

Input power $= W.\mu_S \left[\omega_R^3 R_R^2 + 39.5.n^3.r^2(\Omega + \gamma)\right] + Wghn$

$= 1012 \times 0.464 \left[2.59^3 \times 0.985^2 + 39.5 \times 1.37^3 \times 0.203^2(1.135)\right]$

$+ 1012 \times 9.81 \times 0.484 \times 1.37$

$= 10.15 + 6.58$

Input power = 16.73 kW

Basic Requirements of Power Train

1.	Input rpm	1006
2.	Output rpm	66.67
3.	Hours running	8
4.	Shock conditions factor	1.0
5.	Power required	16.73 kW

$\therefore$ modified output $= 16.73 \times 1.0 = 16.73$ kW

output torque $= \dfrac{16.73 \times 9545}{66.67} = 2395$ Nm

Check gear-box tables

A suitable unit would be a 2000 which is rated at 23.9 kW and a torque of 3300 Nm.

At this stage it may be considered that the standard tip speed may not be high enough to drive the mix around an 0.203 stator, so it is reasonable to check the power needs for a disc running at a higher speed. The next available gear-box speed is 80 rpm at the output shaft.

This would give an equivalent prototype disc speed of 228 rpm. This would seem to be reasonable based on the test work.

Hence $\omega = \dfrac{80 \times 2\pi}{60} = 8.4$ rad/s

$\omega_R = 8.4 \times .37$

$\omega_R = 3.1$ rad/s

$\therefore \quad n = \sqrt[3]{w_R}$

$n = 1.46$

Again,

Input power $= W.\mu_S \left[w_R{}^3 R_R{}^2 + 39.5\ n^3 r^2\ (\Omega + \gamma) \right] + Wghn$

The changed values will be w_R and n.

$\therefore \quad = 1012 \times 0.464 \left[3.1^3 + 0.985^2 + 39.5 \times 1.46^3 \times 0.203^2\ (1.135) \right]$

$+ \ 1012 \times 9.81 \times 0.464 \times 1.46$

Input power = 23.0 kW

$\therefore$ Output torque $= \dfrac{23.0 \times 9545}{80} = 2744$ Nm

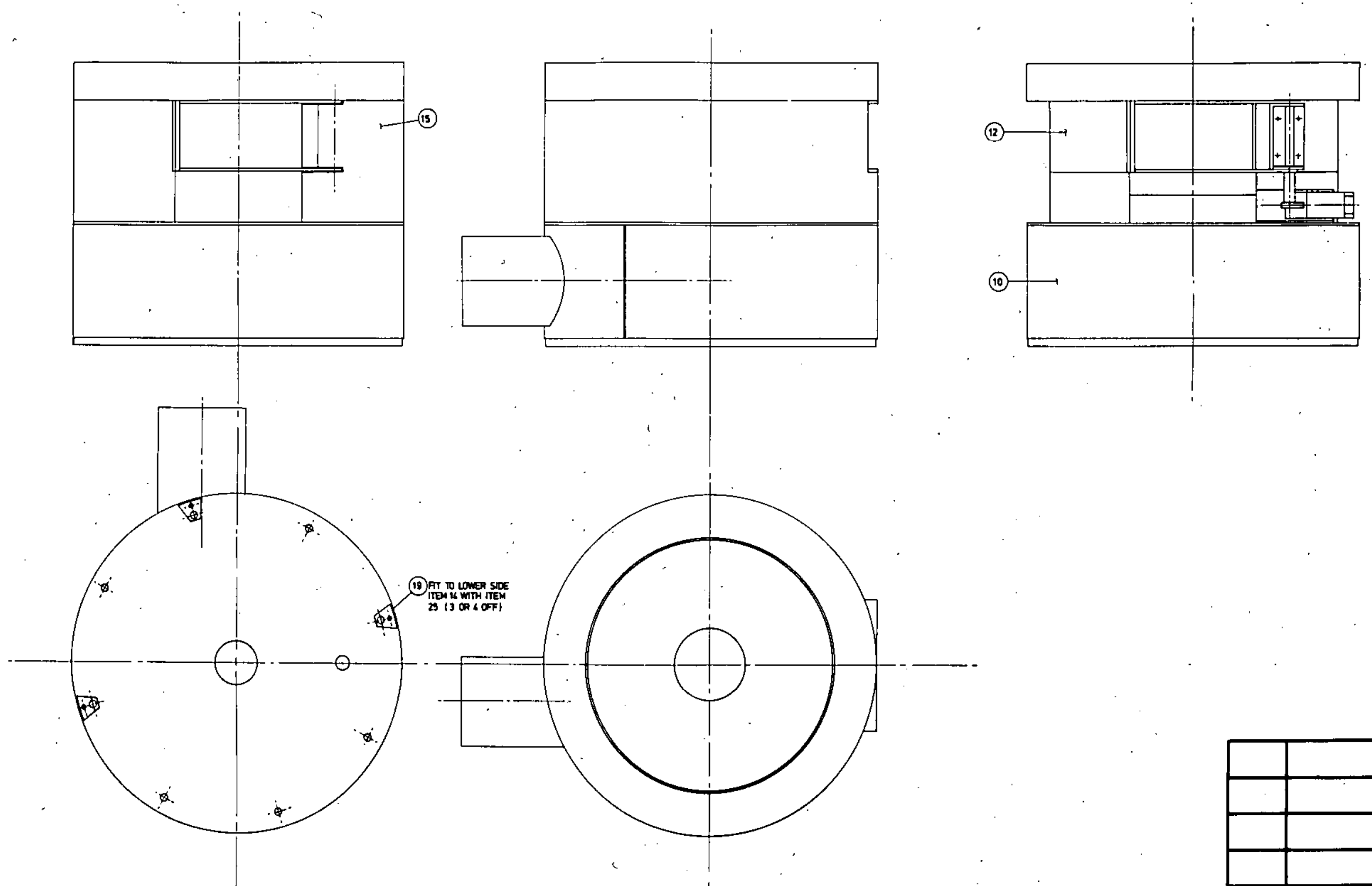
Gearbox rating is 27 kW at 3010 Nm torque, this again uses a 2000 series box.

In conclusion it may be seen that the gearbox range would cover all the needs of the pre-production mixer models.

APPENDIX

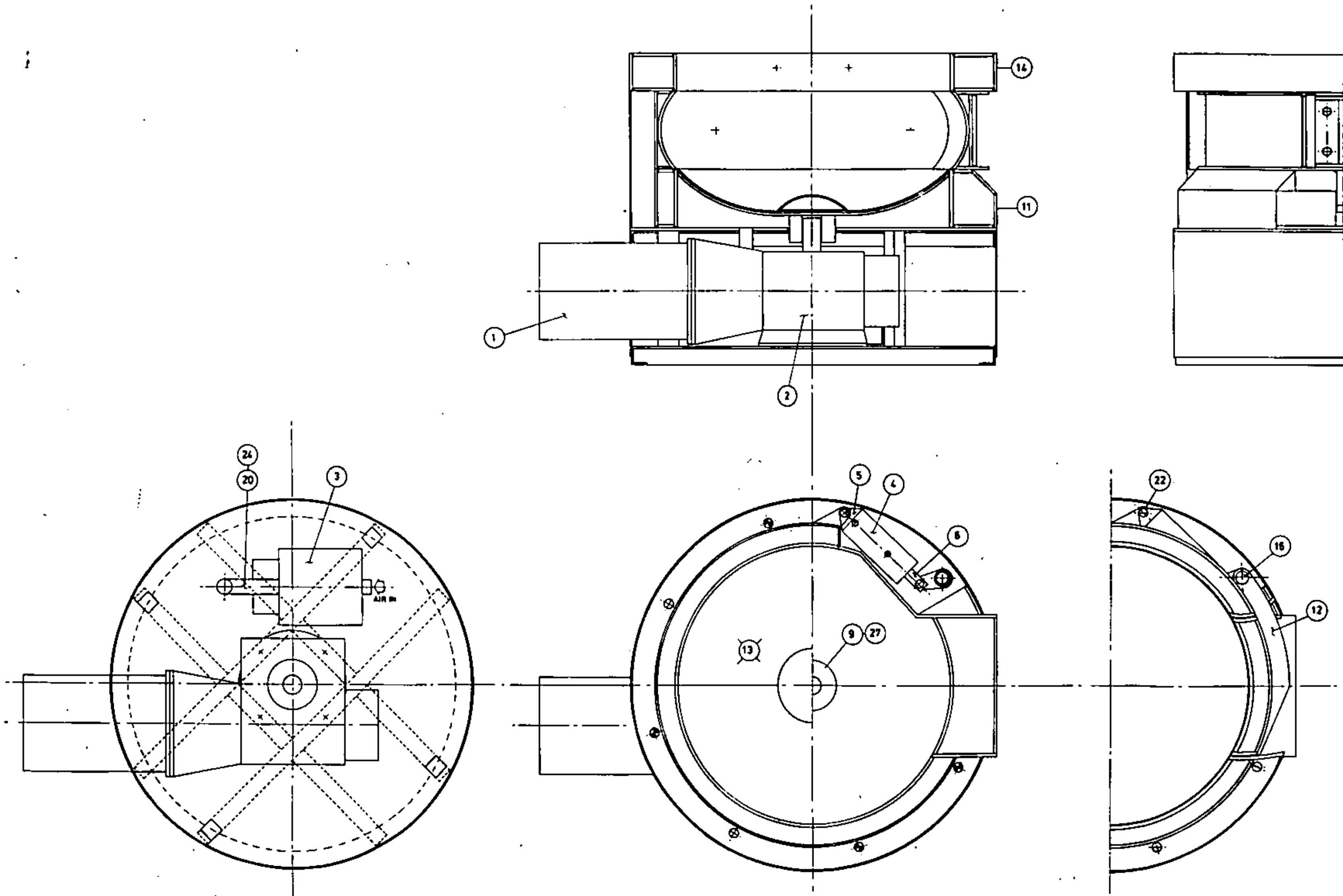
M

MIXER & BATCHING PLANT DRAWINGS



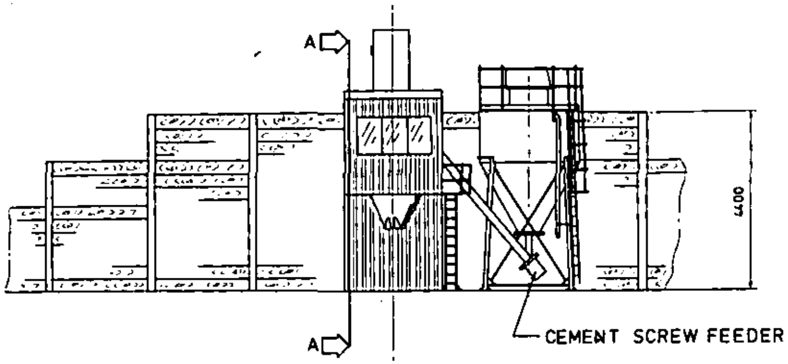
Issue	Modification	Date

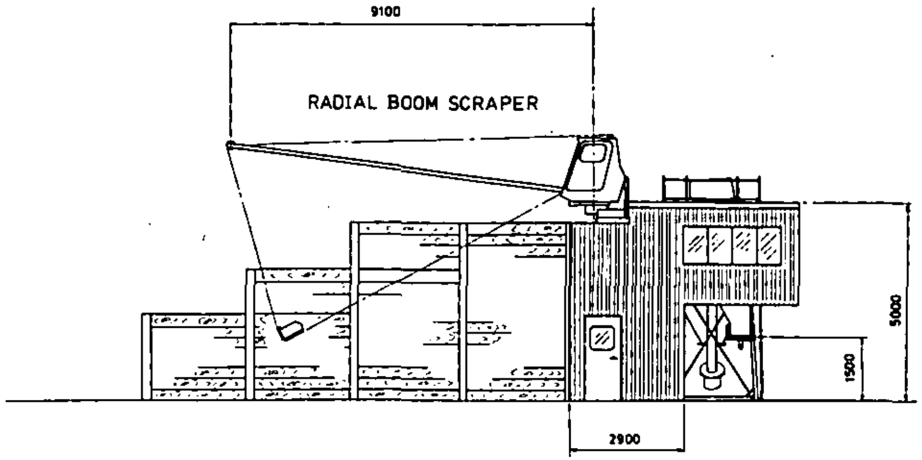
75W0011SHT1

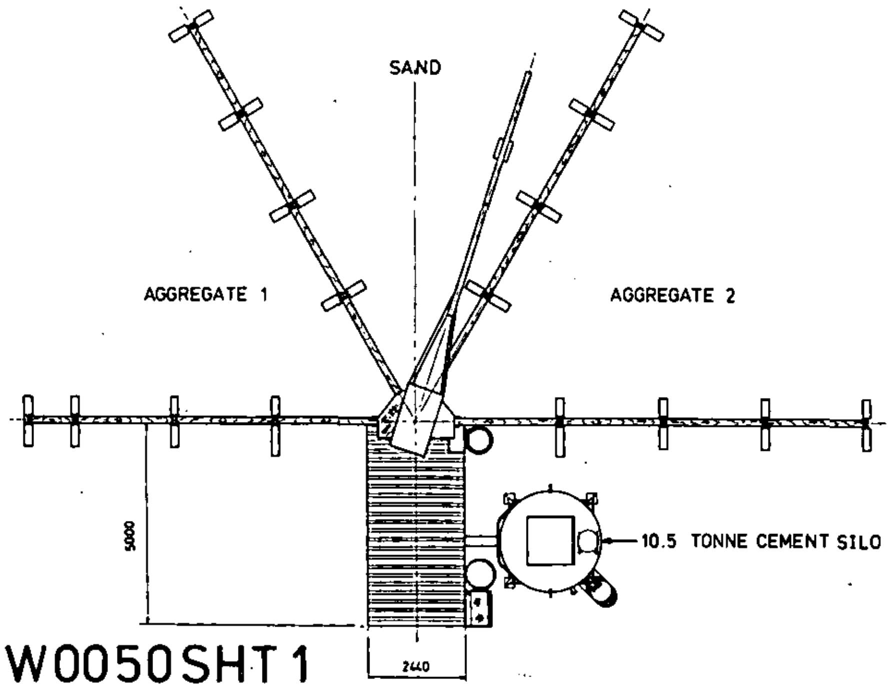


75 W0011 SHT 2

Issue	Modification	Date

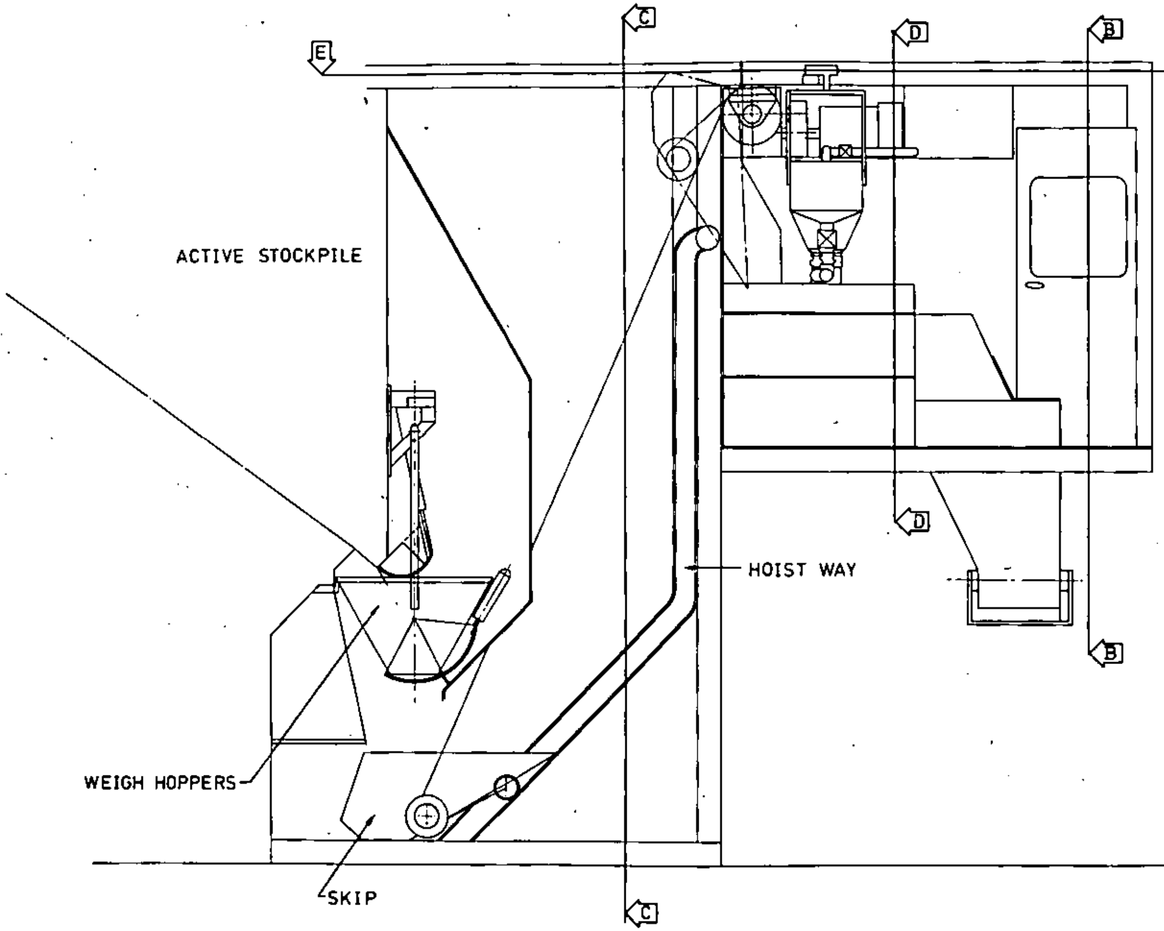




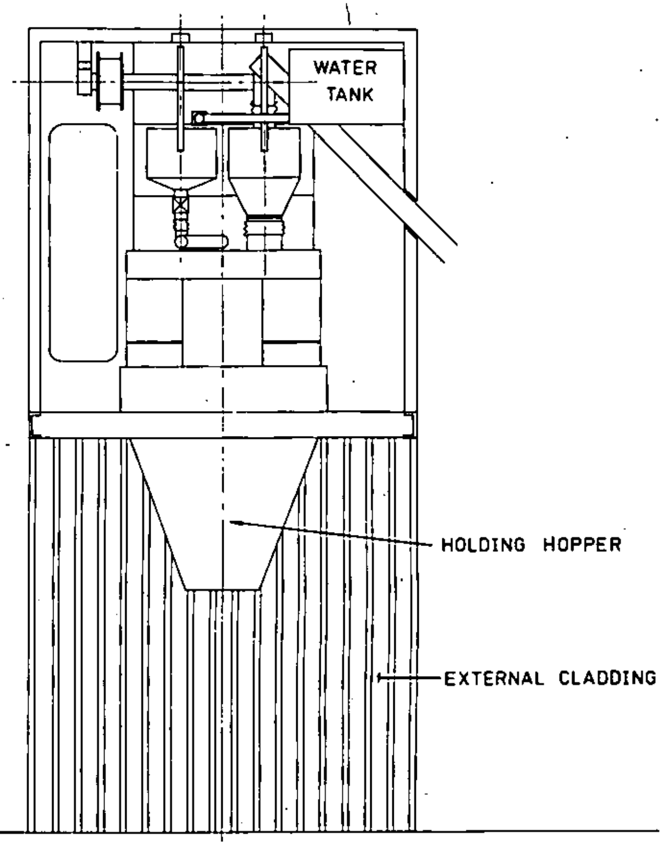


75W0050SHT1

Issue	Modification	Date



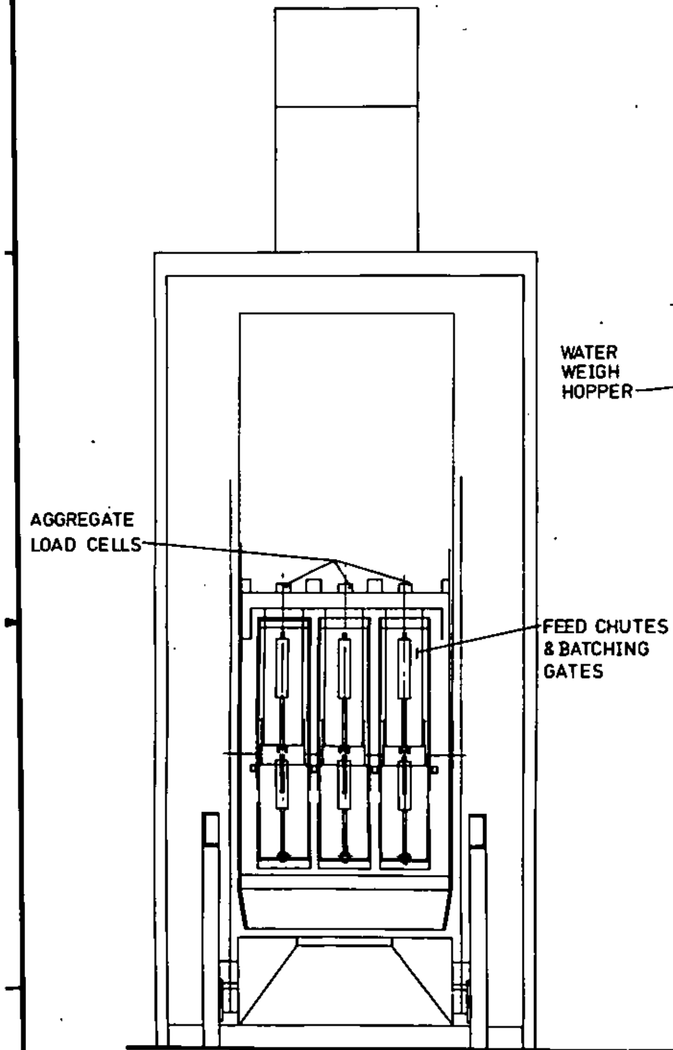
SECTION A A



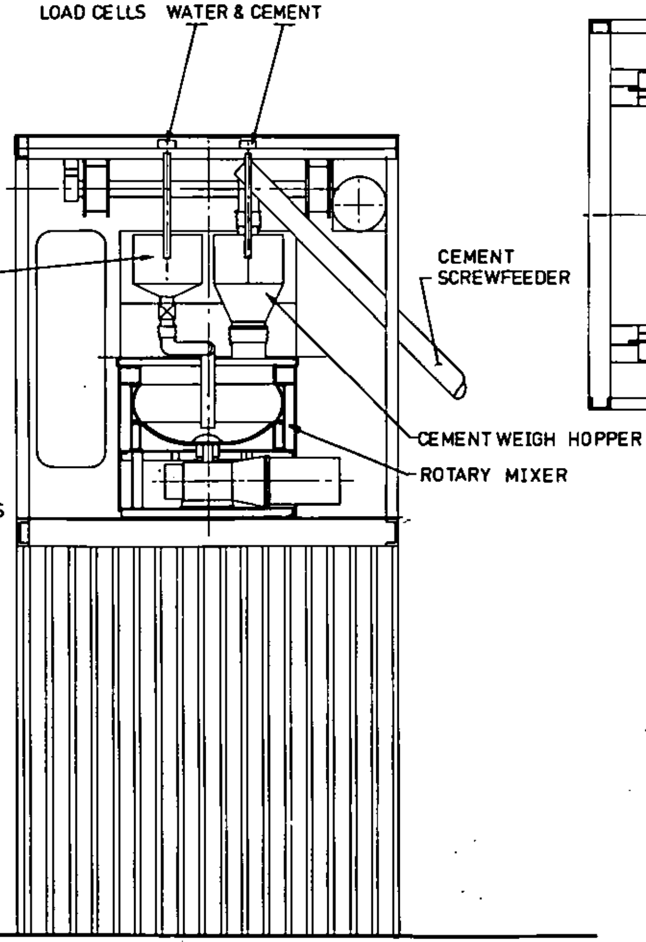
SECTION B B

Issue	Modification	Date

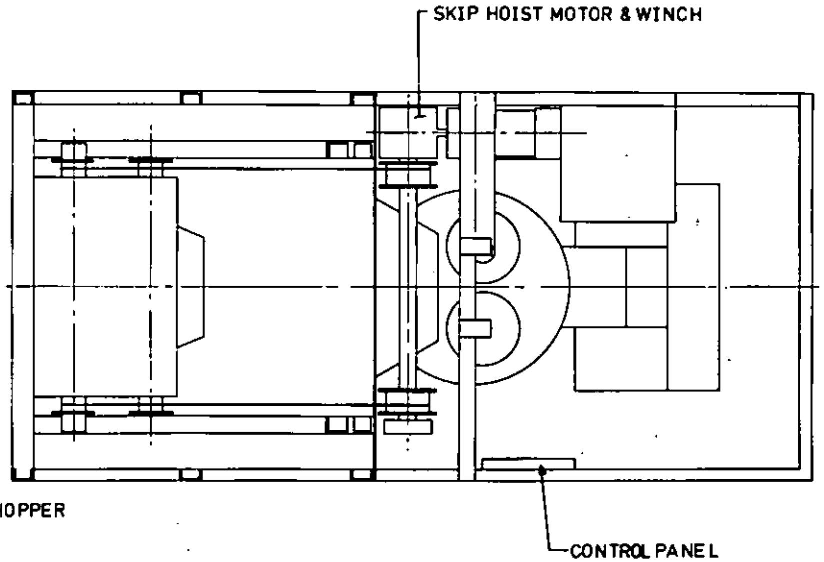
75W0050 SHT 2



SECTION CC
(COVERS REMOVED)



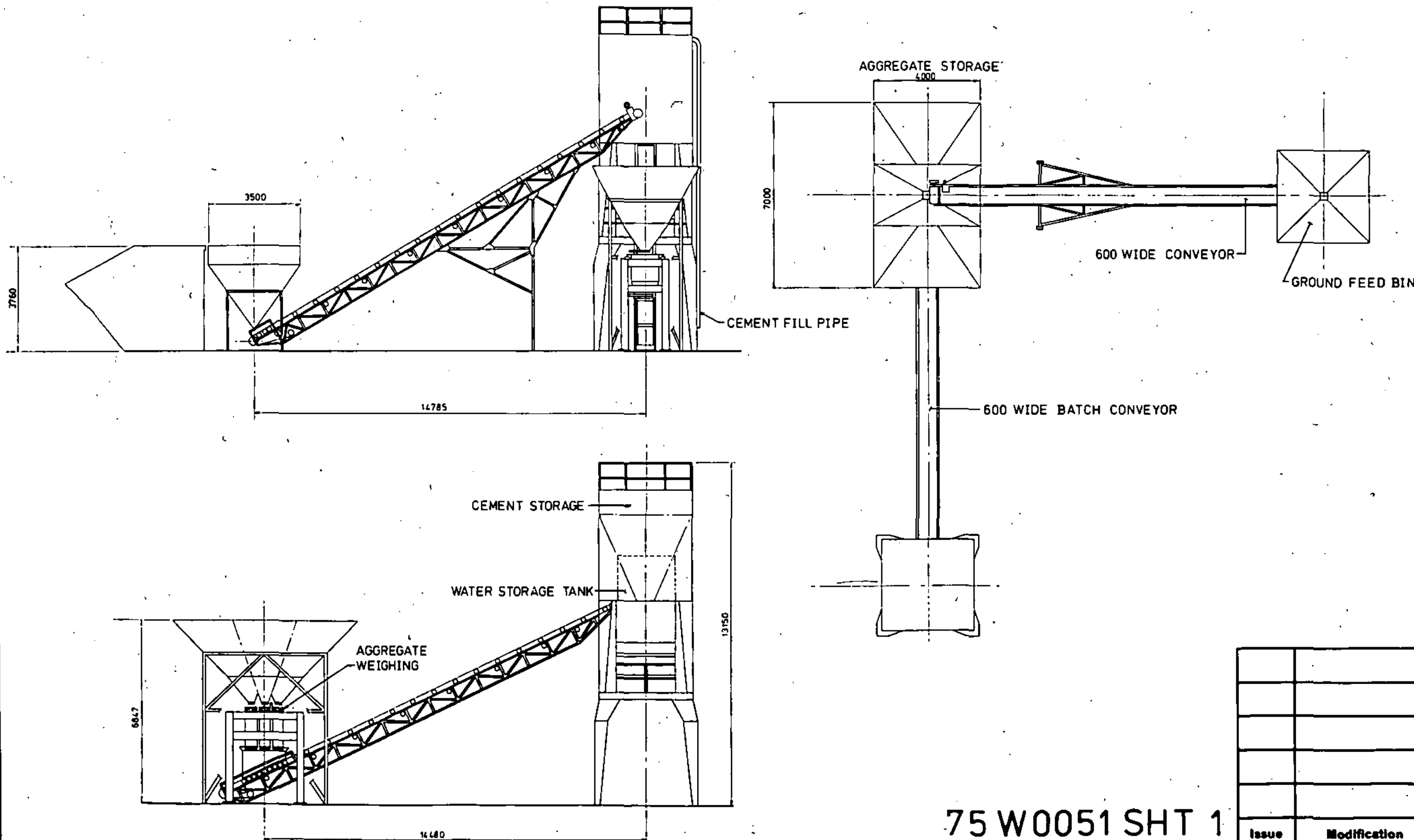
SECTION DD



SECTION E E

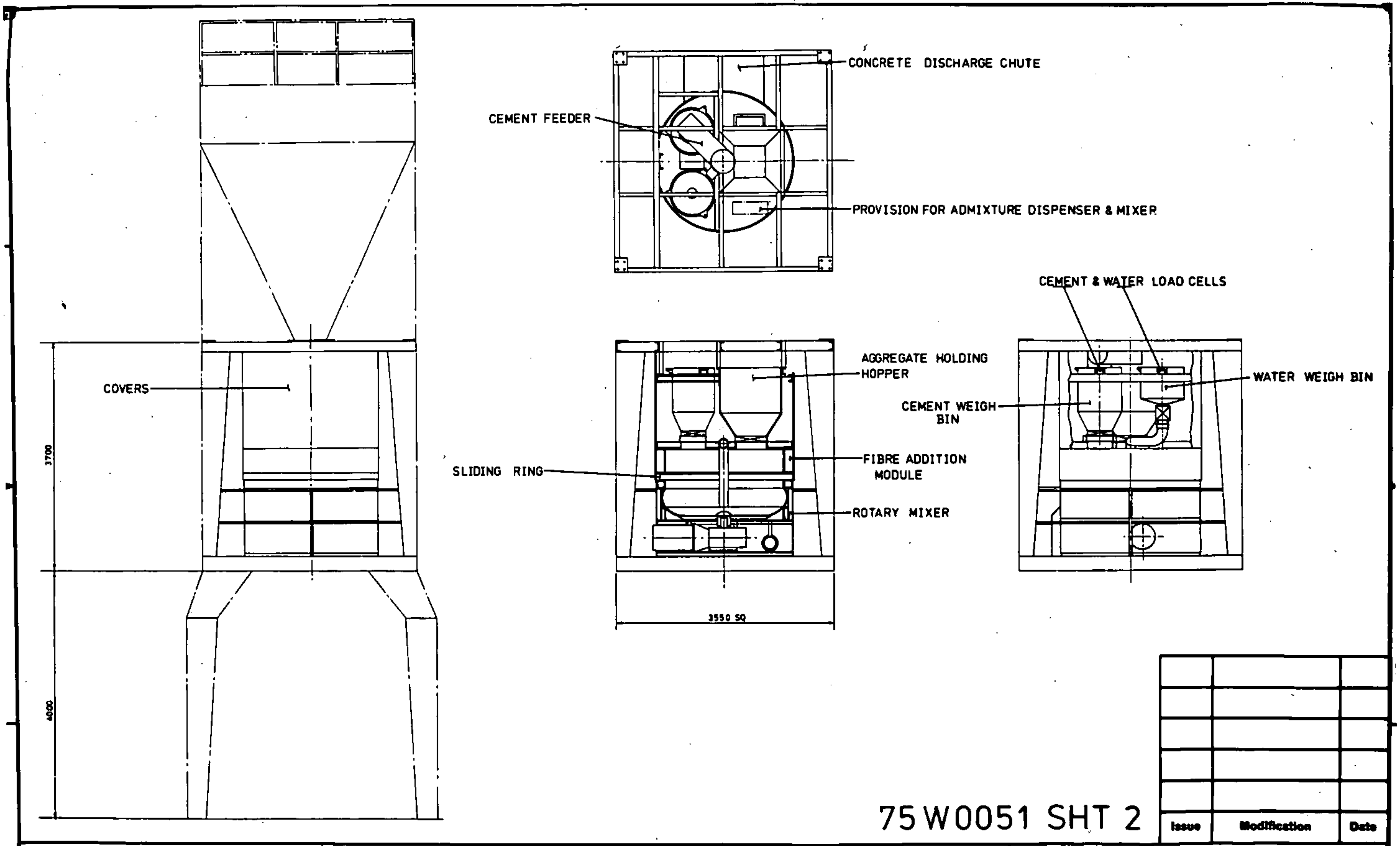
75 W0050 SHT 3

Issue	Modification	Date

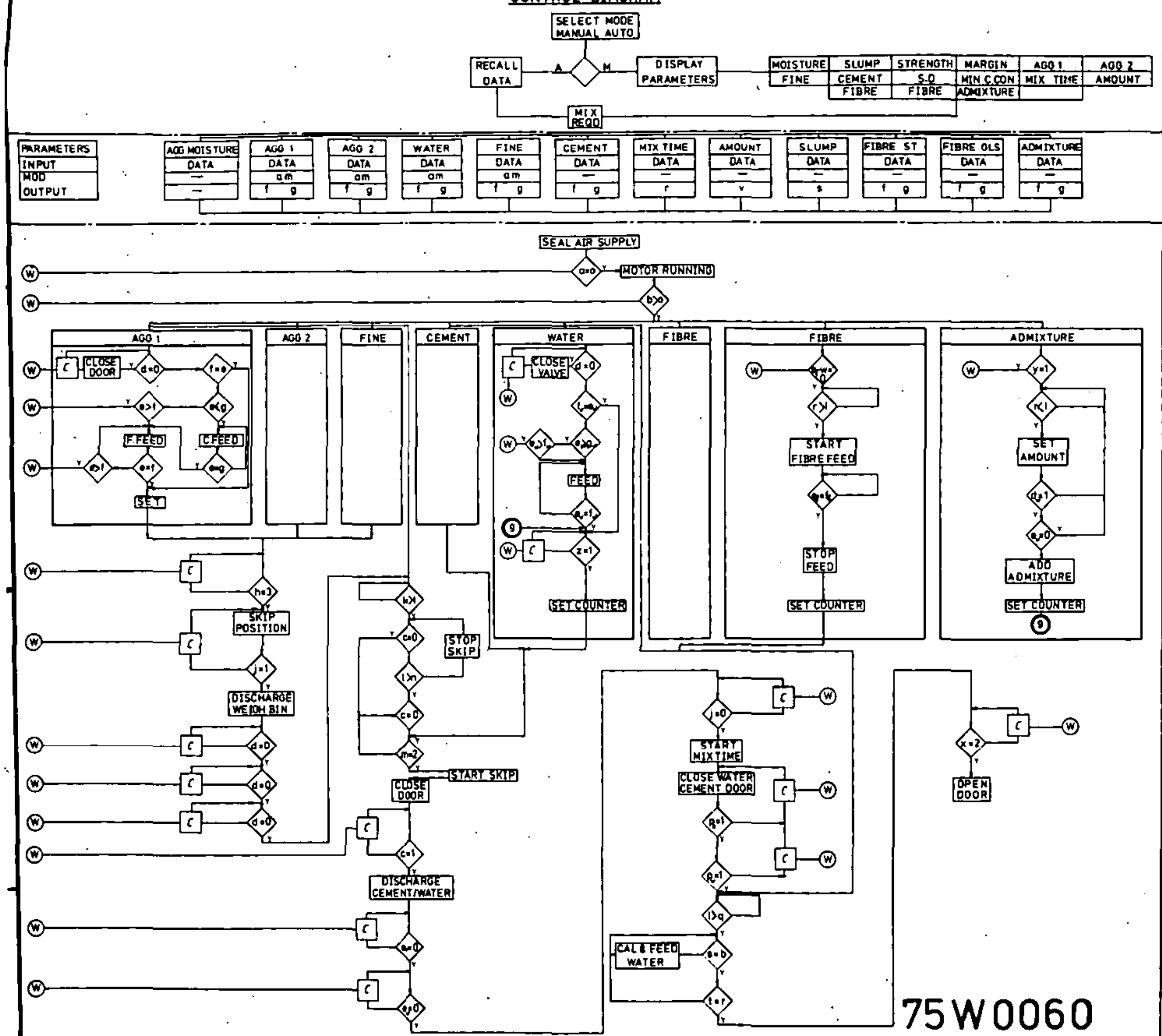


75 W0051 SHT 1

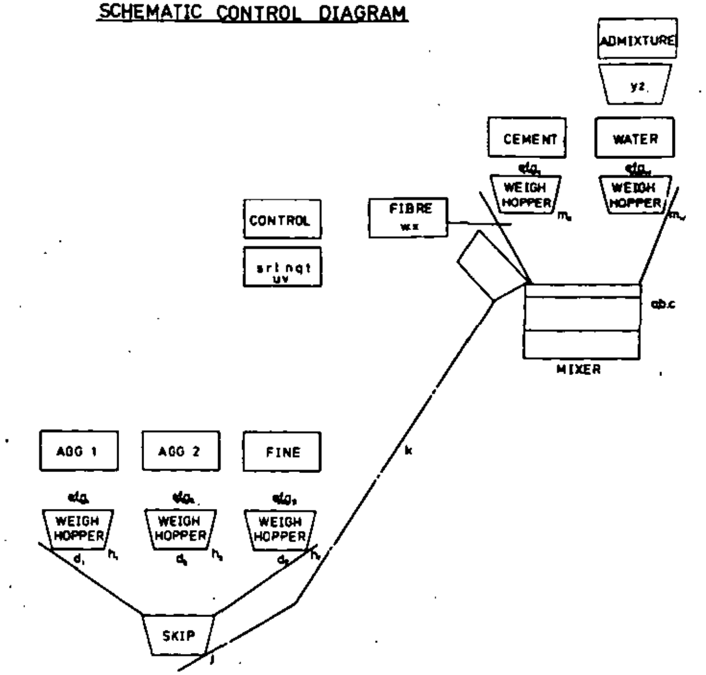
Issue	Modification	Date


CONCRETE DISCHARGE CHUTE
CEMENT FEEDER
PROVISION FOR ADMIXTURE DISPENSER & MIXER
CEMENT & WATER LOAD CELLS
AGGREGATE HOLDING HOPPER
WATER WEIGH BIN
CEMENT WEIGH BIN
COVERS
3700
FIBRE ADDITION MODULE
SLIDING RING
ROTARY MIXER
4000
3550 SQ
75 W 0051 SHT 2
Issue
Modification
Date

CONTROL DIAGRAM



SCHEMATIC CONTROL DIAGRAM



KEY TO SYMBOLS

a	Air supply
b	Power readout
c	Mixer door position
d	Weigh bin door position
e	Load cell reading
f	Required load cell reading
g	90% required load cell reading
h	Counter aggregate weigh bins
j	Skip position
k	Length of time hoist bottom to top
l	Time to end of mix
m	Cement and water bin counter
n	Time to close mixer door
p	Cement valve position
q	Minimum time for slump check
r	Mix time
s	Slump
t	Actual mix time
u	Number of batches
v	Actual number of mixes
w	Fibre zero stock
x	Fibre counter
y	Admixture low level
z	Admixture counter

a = admixture
c = cement
w = water
f = fibre

(W) Warning Light
C Counter
◇ Decision

0 = Open/on/up
1 = Closed/off/down

Issue	Modification	Date

75W0060