

5-24-1979

The effects of polyethylene oxide on DMAAC's "B" type developer

Harold McCullough

Follow this and additional works at: <http://scholarworks.rit.edu/theses>

Recommended Citation

McCullough, Harold, "The effects of polyethylene oxide on DMAAC's "B" type developer" (1979). Thesis. Rochester Institute of Technology. Accessed from

This Thesis is brought to you for free and open access by the Thesis/Dissertation Collections at RIT Scholar Works. It has been accepted for inclusion in Theses by an authorized administrator of RIT Scholar Works. For more information, please contact ritscholarworks@rit.edu.

To the Rochester Institute of Technology,
Department of Photographic Science
and Instrumentation

Senior Research Thesis

The Effects of Polyethylene Oxide on
DMAAC's "B" Type
Developer

by

Harold M. McCullough

May 24, 1979

Thesis advisor: Dr. Burt H. Carroll

Abstract

This report describes the results of a study comparing ASA speed, contrast index, and resolution from a developer time series. The time series was made on six levels each of PEO-400, -600, -1000, and -1500 added to DMAAC's "B" developer. Kodak's SO-277, low contrast, and SO-243, high contrast, aerial duplicating films were used. Results show that PEO-400, at a concentration of 30ml/l, can be a material help in getting higher speeds and contrast index from SO-277 aerial duplicating film without loss of resolution.

The Effects of Polyethylene Oxide on
DMAAC's "B" Type
Developer

Introduction

Polyethylene Oxides* have been shown to act as both development accelerators and inhibitors. Several factors seem to effect the results obtained when PEO is added to developers. A few of these factors are: type of emulsion, developer agent used, what is the combination if a combination of developer agents are used.^{1,2,3,4,5,6,7,8} PEO compounds of the general formula; HO-(CH₂-CH₂-O--CH₂-CH₂)_n-OH** have been studied.^{1,9} It has also been shown that the PEO effect depends somewhat on the level of illuminance when a photographic emulsion is exposed.²

Emulsions containing PEO offer the possibility of higher speed for camera films without the loss of resolution.⁸ Developers containing PEO offer methods

* PEO will be used throughout as a generic abbreviation for polyethylene oxides (glycol). Types of PEO refer to chain length.

** n being such that the molecular weight is in the range of 150 to 20,000. (The numbers stand for approximate molecular weight.)

of altering ASA speed and contrast index characteristics of film emulsions not containing this compound.^{1,8}

Much work has been done on the addition of PEOs and allied compounds to both emulsions and developers.¹ Wood has theorized extensively on the development mechanism with reference to PEO.^{4,5,10} However, the justification of this theory was not within the scope of this study.

The Defense Mapping Agency Aerospace Center has had some success with the addition of PEO-400 to its "B" type developer.⁸ It has offered a method of increasing the contrast index of low contrast aerial duplicating films without the unwanted side effects of other methods.

It is known that raising the temperature, one method of increasing contrast, has the side effect of increasing base-plus-fog. This destroys resolution in the toe portion of the image in films like Kodak's SO-277 and SO-243.

The Purpose of this study was to determine an optimum amount and chain length of PEO to be added to the "B" developer to maximize speed and contrast index for SO-277, and hold to a minimum the change in contrast index for SO-243.

Method

Equipment:

A Kodak model 101 sensitometer was used to expose sensitometric strips. The head was set up with a continuous gray wedge and the Quanta-Scan Automatic Densitometer was used to trace the characteristic curves after development. RIT's dip tank processor with intermittent, nitrogen burst agitation was used to develop the strips. A 100X microscope was used to read the resolution targets.

Procedure:

Processing conditions were set as close as possible to simulate processing with a Kodak Versamat continuous roll-film processor. Developer temperature was held at 90^oF for all experiments. To duplicate reasonable times available on the Versamat, a time series of 15*, 30, 60, 120, and 190* seconds was run on each concentration level.

* Fifteen seconds represents the fastest speed practicable through one rack of the Versamat. One-hundred-ninety seconds is the slowest, repeatable speed through the double development racks.

Levels of concentration were varied for each PEO. When concentration level started causing excess base-plus-fog, the level series was terminated. PEO-400 was added at four levels: 15, 30, 60, and 120 ml/l. PEO-600 was added at five levels: 5, 10, 20, 30, and 40 ml/l. PEO-1000 required three levels to reach excess base-plus-fog: 4, 8, and 16 ml/l. PEO-1500 required three levels also: 3, 6, and 12 ml/l.

A pH change series was made to see if this could be considered as an alternate method of increasing the speed and contrast index of S0-277. For this method to be acceptable, it must not increase the contrast of S0-243 too much. The series tested was: pH 10.04 (basic developer), 10.25, 10.50, 10.75, and 11.00.

The correct density of the original continuous gray wedge was determined by tracing the edge where nicks were cut. When a nick was encountered, the Quanta-Scan gives a sharp dip in the trace. The nicks corresponded to density increments of $.30 \pm .01$. The log H scale was easily determined this way. The log H at the film plane of the sensitometer was 2.53.

Five-hundred strips each were cut from rolls of S0-277 and S0-243. They were then exposed on the 101 sensitometer, aged for 24 hours, and then placed in the freezer. A four hour thaw time was allowed before use.

DMAAC's "B" type developer formula is listed in Table 1. A time series on the basic developer was replicated four times to be used as a comparison for the pH and concentration level changes. Changes in pH were achieved by adding sodium carbonate and/or sodium hydroxide. The PEOs were introduced to the basic developer before final H₂O was added. Developer temperature was controlled by placing the dip tank in a water bath. The water bath temperature had to be high enough to offset the cooling effect of the nitrogen burst agitation.

Table 1. Developer Formula - DMAAC "B" Type		
	<u>g/l</u>	
Hq	11.0	The basic formula
Phenidone	0.8	should have a pH
Sodium Sulfite	45.0	of 10.04. The
Sodium Carbonate	35.0	concentration of
KBr	3.0	PEO-400 used at
Benzotriazole	0.2	DMAAC is 26.6 ml/l.
H ₂ O to make.....	1/liter	

After normal fixing, washing, and drying, the sensitometric strips were traced with the Quanta-Scan.

The zero (0), PEO-m1/1, plot represents the data for the basic developer. It was connected to the PEO-400 plot as a representative trend.

Resolution was graphed for the PEO-400 series only. Resolution usually deteriorated because of base-plus-fog getting too high. $R = \text{Resolution}/100$ on the chart.

One standard deviation (s) of the ASA speed and contrast index was plotted on the one minute PEO-400 runs.

R = Resolution/100
 1 = PEO-400
 2 = PEO-600
 3 = PEO-1000
 4 = PEO-1500

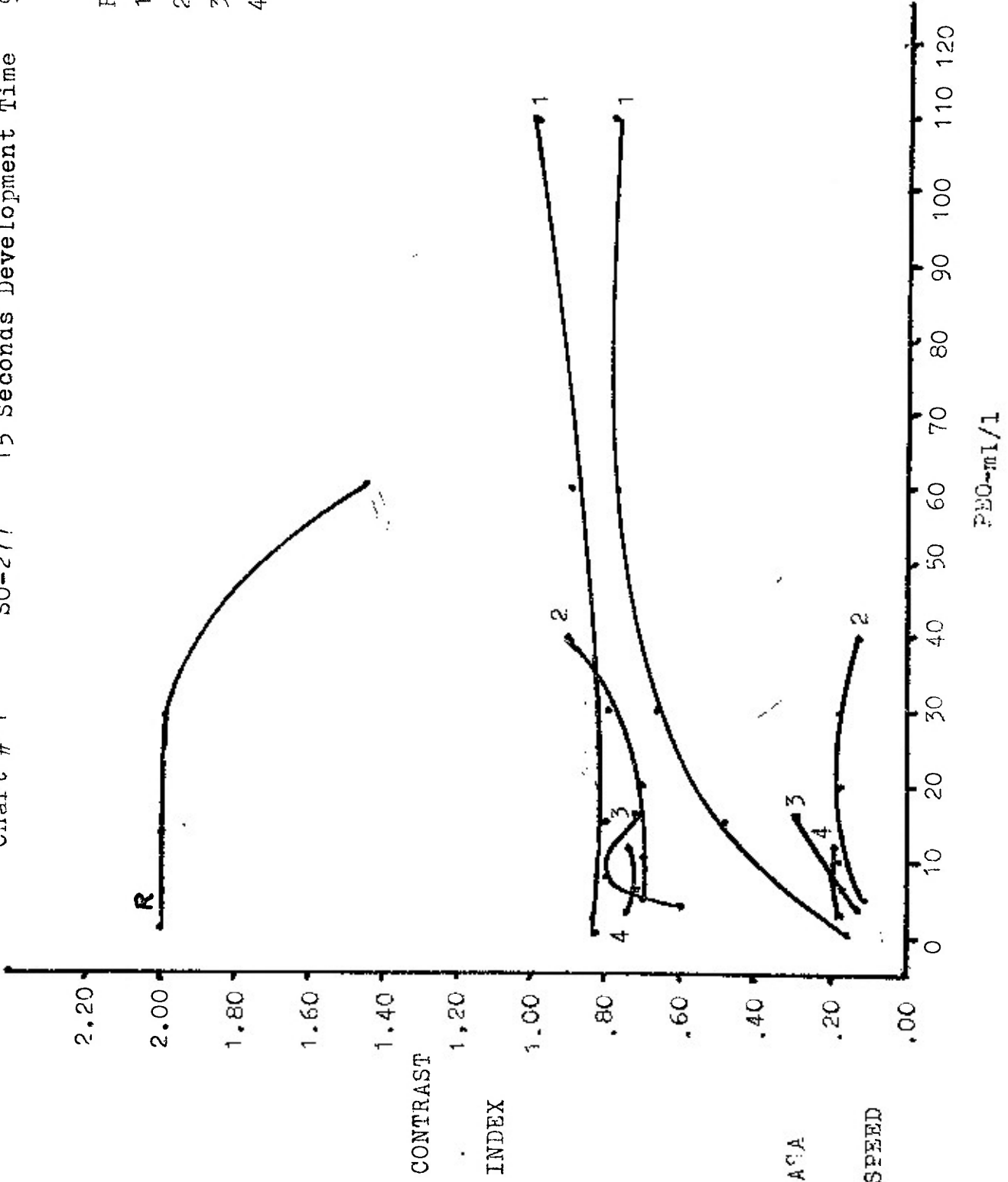


Chart # 2 SO-277 30 Seconds Development Time 90°F

R = Resolution/100
1 = PEO-400
2 = PEO-600
3 = PEO-1000
4 = PEO-1500

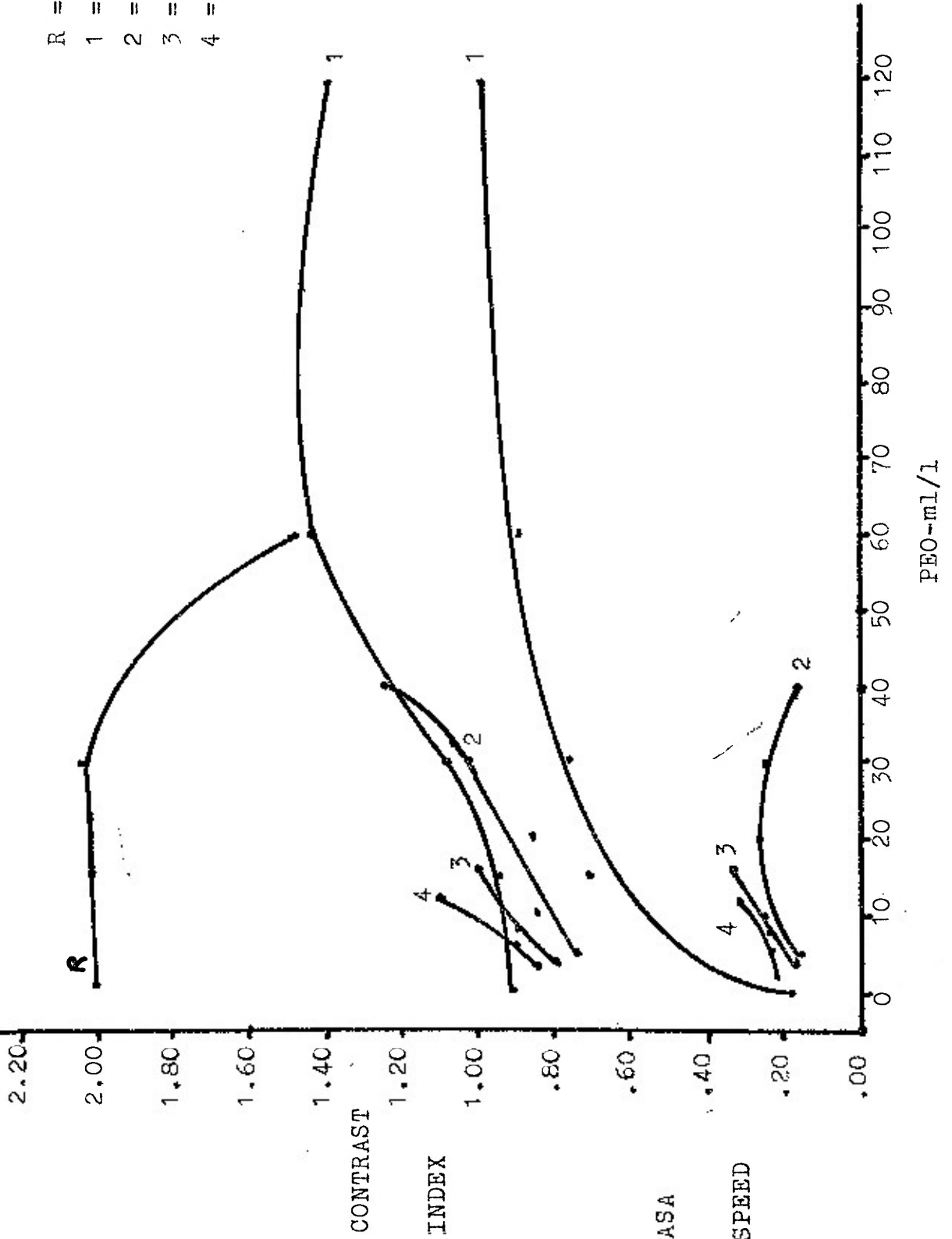


Chart # 3 SO-277 60 Seconds Development Time 90°F

R = Resolution/100
 1 = PEO-400
 2 = PEO-600
 3 = PEO-1000
 4 = PEO-1500
 - - - = 1A

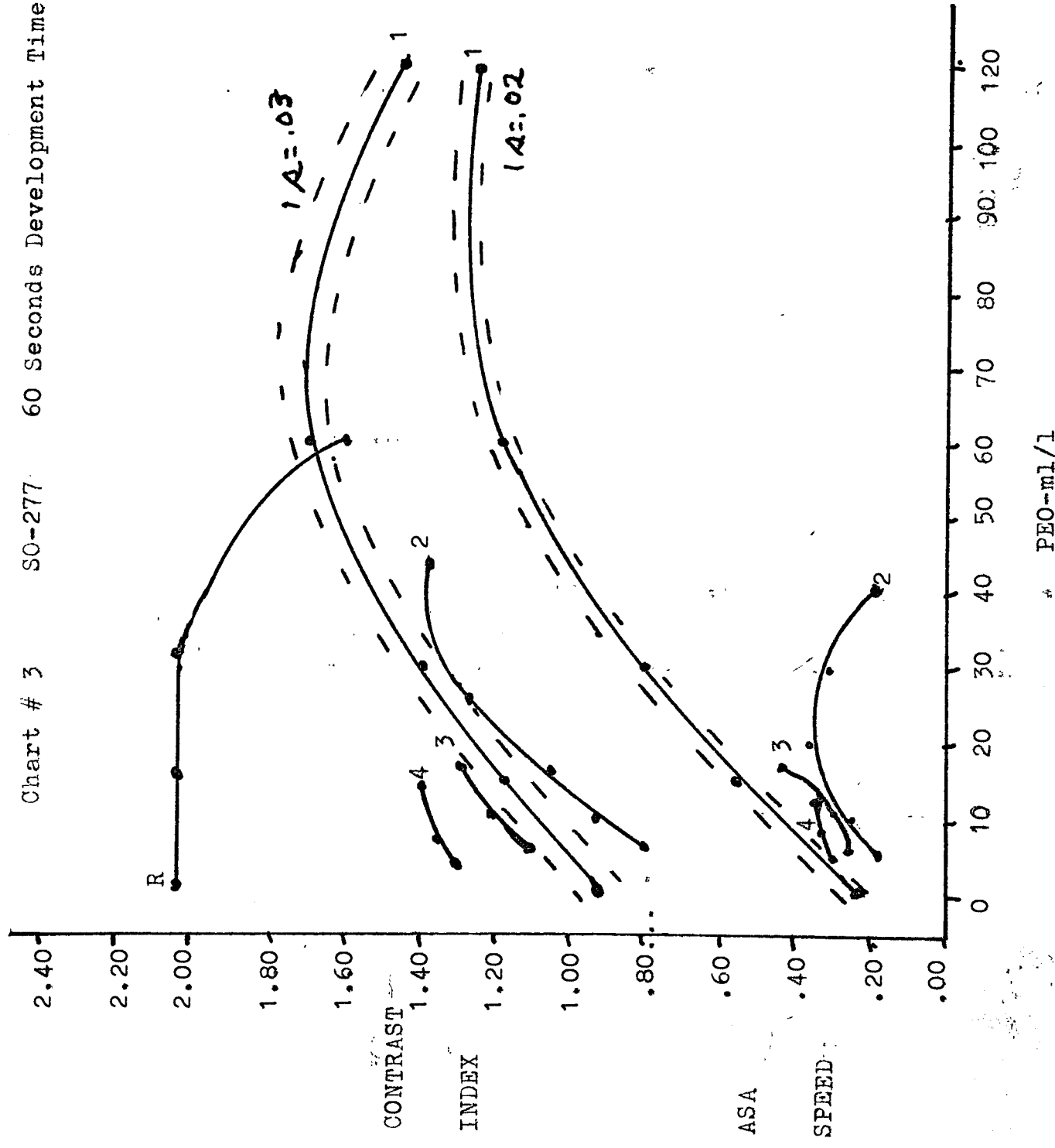


Chart # 4 SO-277 120 Seconds Development Time 90°F

R = Resolution/100
 1 = PEO-400
 2 = PEO-600
 3 = PEO-1000
 4 = PEO-1500

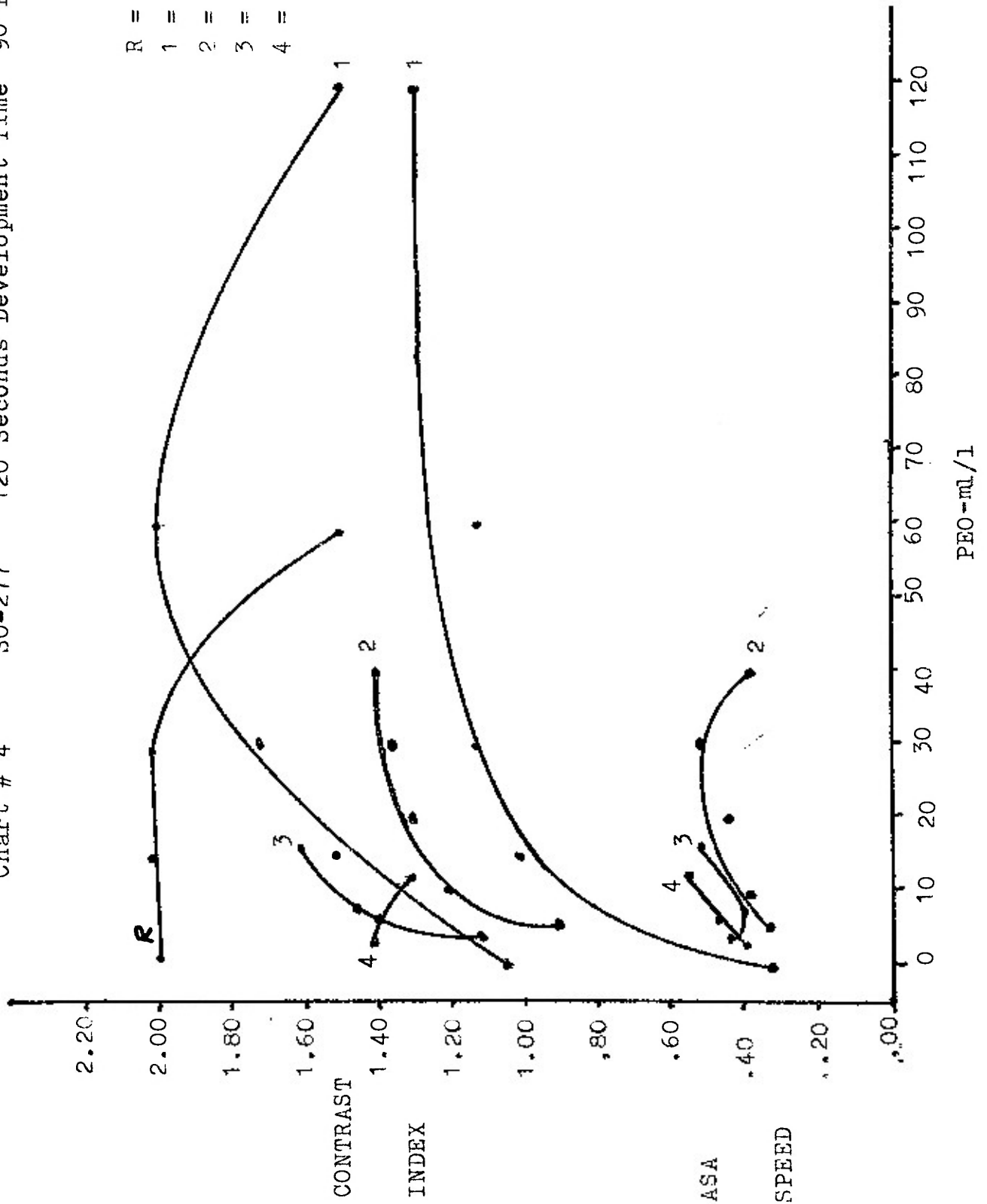


Chart # 5 SO-277 190 Seconds Development Time 90°F

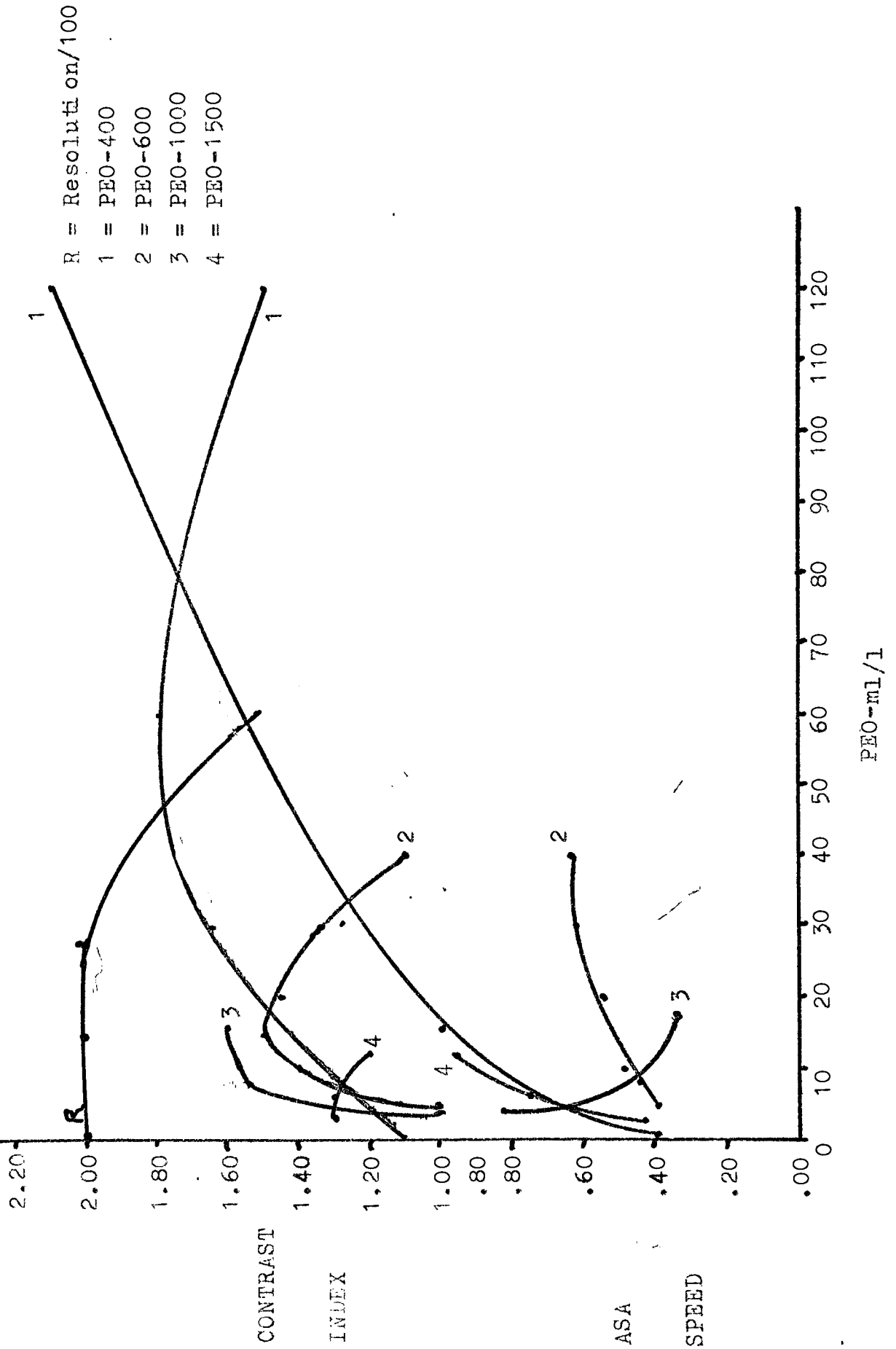
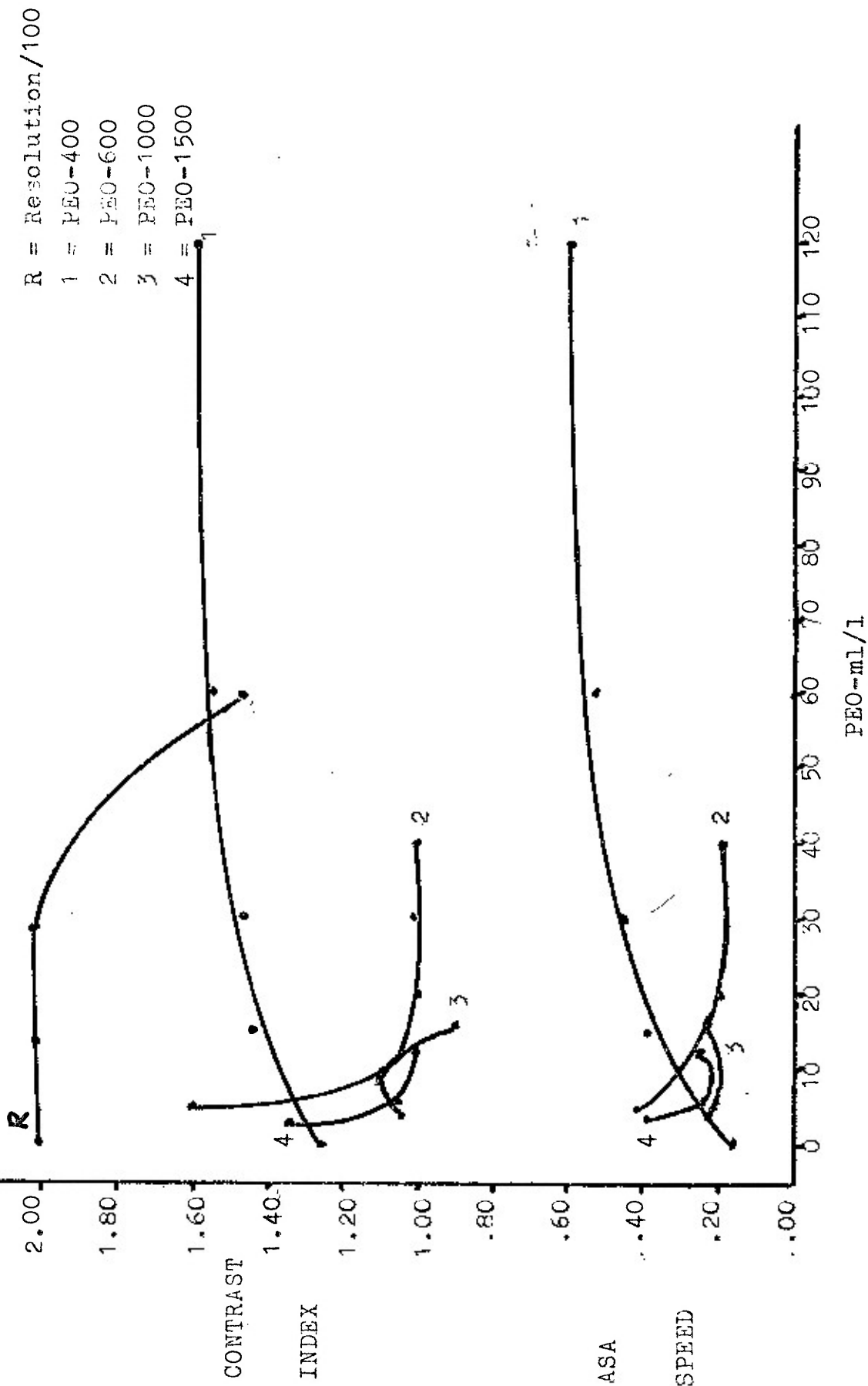


Chart # 6 SO-243 15 Seconds Development Time 90°F



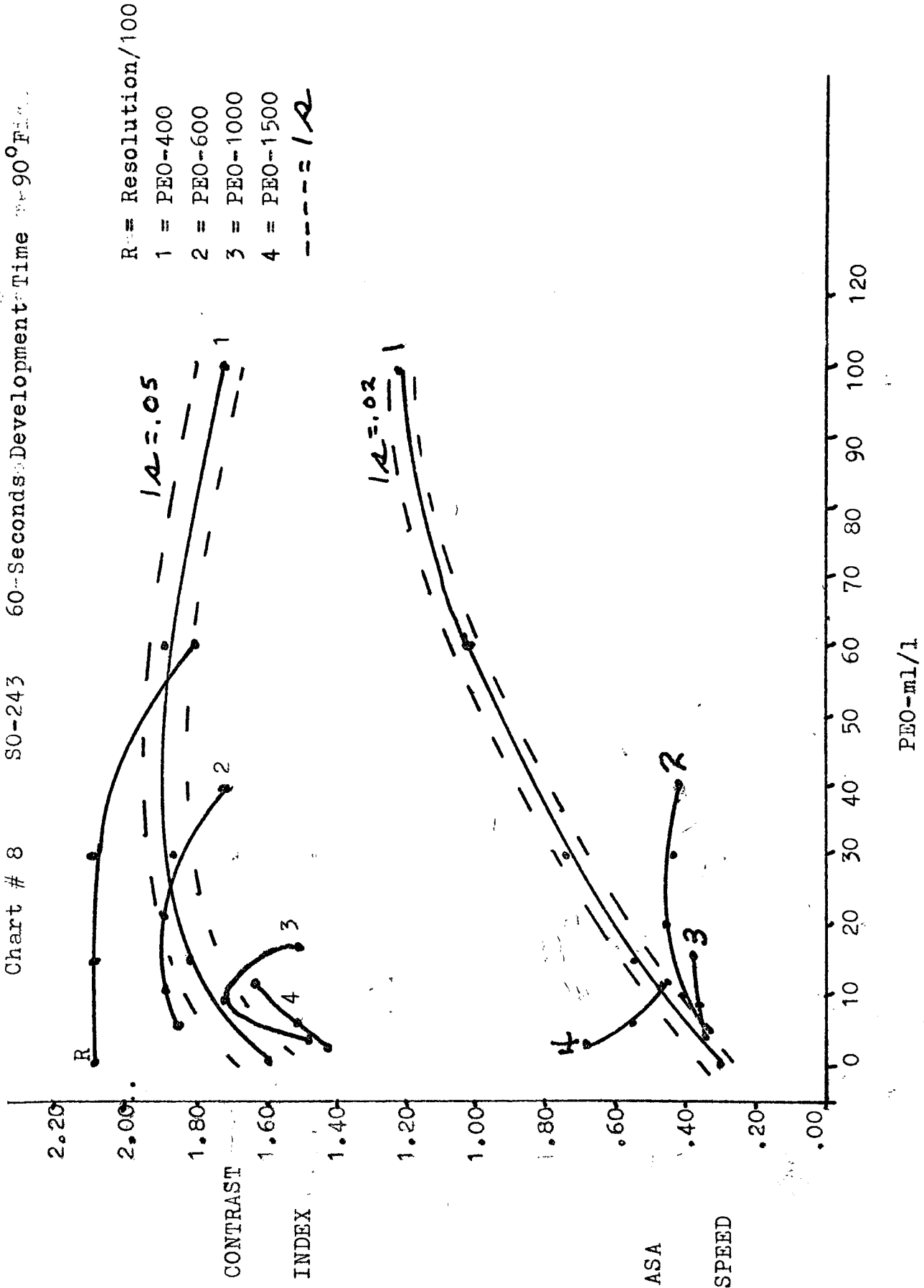
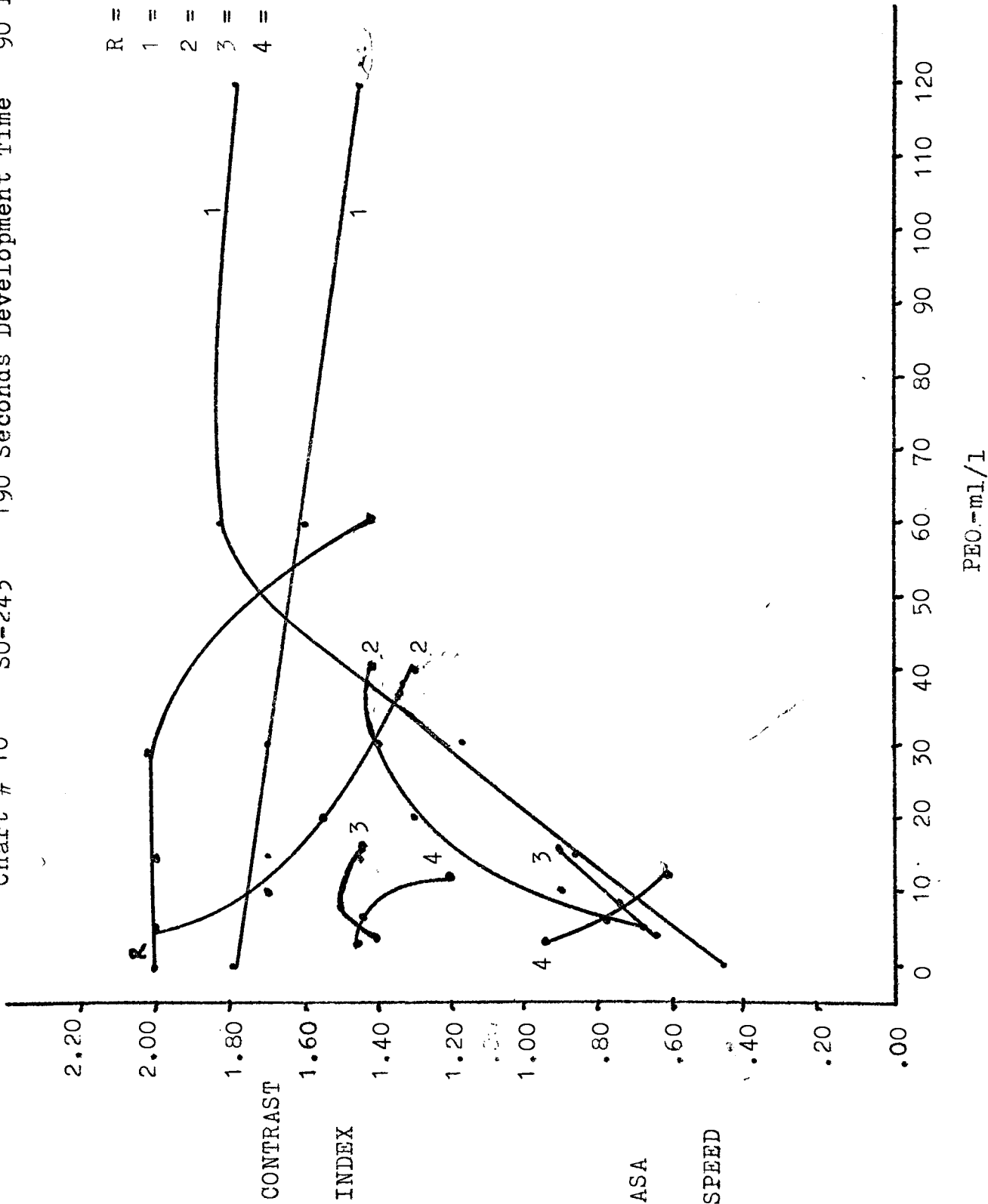


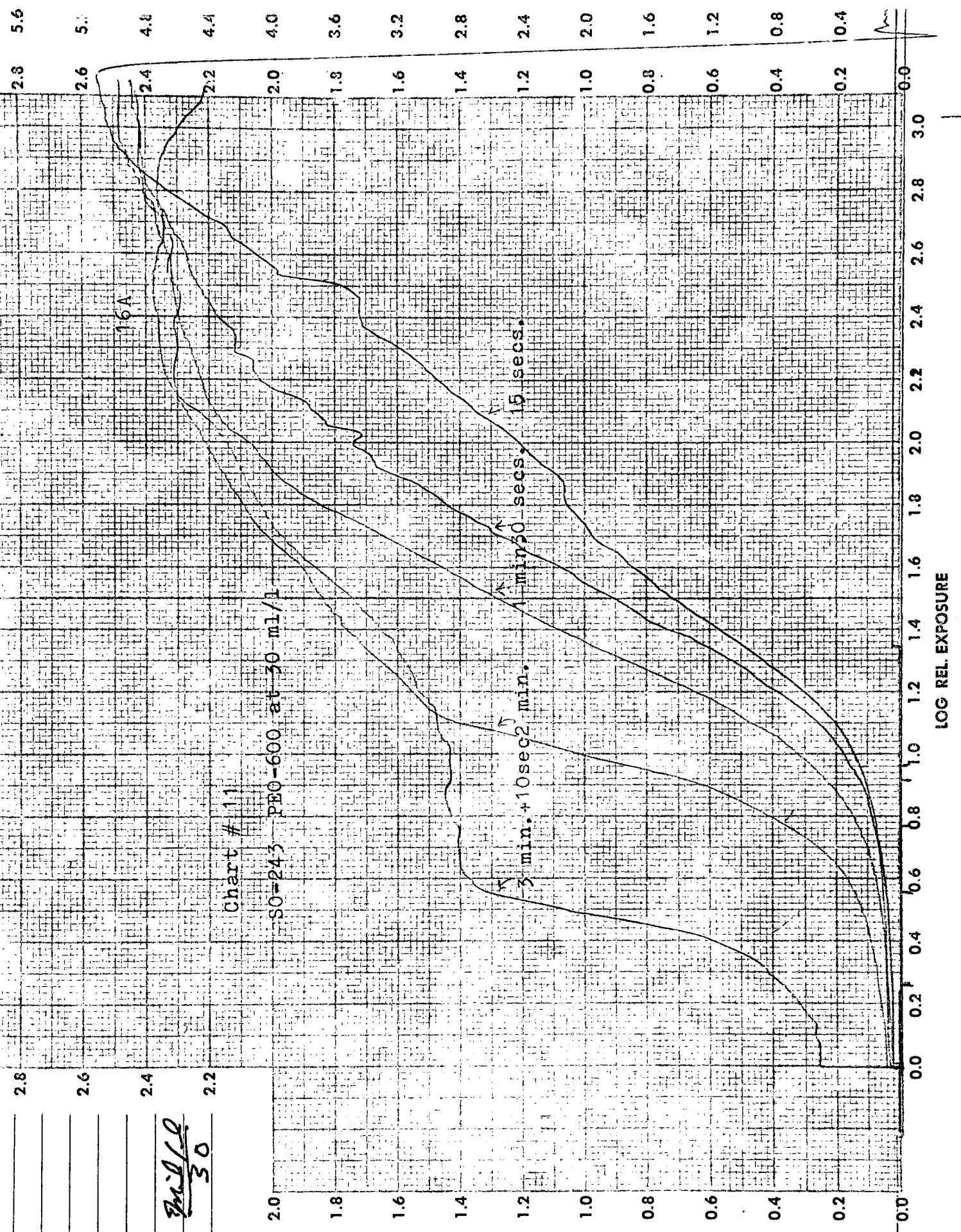
Chart # 10 SO-243 190 Seconds Development Time 90°F

R = Resolution/100
 1 = PE0-400
 2 = PE0-600
 3 = PE0-1000
 4 = PE0-1500



LOG ES _____
 LOG Ed _____
 LOG E_a _____
 D_d _____
 D_a _____
Paul R
 30

TRANSMISSION/REFLECTION DENSITY



LOG REL. EXPOSURE

Discussion

PEO-400 proved to be best suited for this developer and two film combination. At two minutes development, the SO-277 had an increase in the contrast index of .95. At this same time SO-243 had an acceptable decrease in contrast index. Generally the best speed increases were achieved with the PEO-400. A PEO-400 concentration of 30 ml/l was the cut off point for both films. After this level, resolution fell to an unacceptable level.

PEO-600 gave the poorest results. In most cases the contrast index and speed was lower than that gained by the other PEOs.

AT low concentrations PEO-1000 and -1500 gave a higher contrast index than the PEO-400. When their maximum concentration level was reached (because of base-plus-fog) PEO-400 surpassed them with higher contrast index values. A loss of resolution also occurred at the second level of concentration for PEO-1000 and -1500.

Some general observations were:

- 1) Some PEOs do increase speed and contrast index, but inhibits development in high density areas at the same time.

2) An excess of PEO produces fog.

3) At longer development times a sharp break appears in the sensitometric curve where retardation takes over in the high density end.

4) Only PEO-400 is suitable for DMAAC's type operation. At DMAAC the developer replenisher is stored at room temperature and the PEO added at that temperature. PEO-600, 1000, and 1500 have to be melted and held at a temperature above 90°F. When they are added to a solution at room temperature, they immediately return to a solid state.

5) The contrast index of S0-243 was not adversely affected with PEO-400. Raising the pH of the basic developer caused the contrast index of S0-243 to climb higher than acceptable. See chart #

Recommendations

There are many questions of interest left in the subject of PEOs.

Raising the level of phenidone in DMAAC's "B" type developer should be tested. This could give completely different results. At times the developer acted like a pure Hq developer. Other researchers

have found that PEO decreases speed and contrast with Hq as the only developer agent.^{4,6,7}

Micro-densitometer traces could be run to check resolution better. Granularity and acutance tests could also be performed.

Acknowledgements

I would like to express my gratitude to Dr. Burt H. Carroll for his help and guidance in this research project.