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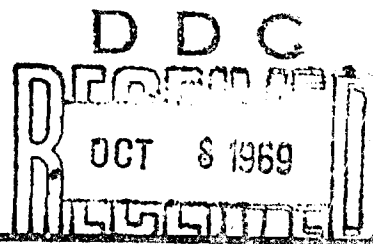
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TECHNICAL MEMORANDUM 1887

COMPILATION OF INFRARED SPECTRA
OF
INGREDIENTS OF PROPELLANTS AND EXPLOSIVES

F. PRISTERA
W. FREDERICKS

SEPTEMBER 1969



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Technical Memorandum 1887

COMPILATION OF INFRARED SPECTRA OF
INGREDIENTS OF PROPELLANTS & EXPLOSIVES

by

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and

W. Fredericks

September 1969

Materials Testing Technology Program

Task Title: Development of Methods of Analysis Using
Atomic Absorption, X-Ray Macro Probe, and Far U. V.
Spectroscopy

AMCMS Code 4930.11.1161.1

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Propellants Laboratory
Feltman Research Laboratories
Picatinny Arsenal
Dover, New Jersey

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Spectra	

OBJECT

To prepare a comprehensive compilations of the infrared spectrograms of the ingredients of Propellants and Explosives which can serve as a reference source to Laboratories engaged in the analysis of Propellants and explosives.

SUMMARY

A comprehensive compilation consisting of 176 infrared spectra of ingredients of propellants and explosives has been prepared and is presented herein. The spectra are arranged in the following groups, which are listed alphabetically, Acetates, Amines, Esters, Metal Organics, Misc., Polymers, Nitro Amines, Nitro Aromatics, Organo Nitrates, Phosphates, Phthalates, Salts, Ureas, Urethanes. Within each group the individual spectra have been arranged in such a way so that related compounds are placed together.

INTRODUCTION

A small compilation consisting of 24 infrared spectra of ingredients of propellants appeared in P.A. Tech Report 1816 "Use of Infrared Spectrophotometry in the Analysis of Propellants". A rather larger compilation of 68 infrared spectra of explosive was presented in P.A. Tech. Report 2254 "Analysis of Explosives by Infrared Spectroscopy", which also described methods and techniques for the analysis of explosives. Since the above mentioned reports were issued many more infrared spectra of ingredients of propellants and explosives have been investigated and prepared. It was therefore considered desirable to prepare a comprehensive compilation of the infrared spectrograms of all the commonly used ingredients of propellants and explosives which can serve as a reference source to Laboratories engaged in the analysis of propellants and explosives.

RESULTS

A comprehensive compilation consisting of 176 infrared spectra of ingredients of propellants and explosives has been prepared and is presented herein. The spectra are arranged in the following groups which are listed alphabetically: Acetates, Amines, Esters, Metal Organics, Misc., Polymers, Nitro Amines, Nitro Aromatics, Organo Nitrates, Phosphates, Phthalates, Salts, Ureas, Urethanes. Within each group the individual spectra have been arranged in such a way so that related compounds are placed together. Thus the mononitrotoluenes are together, so are the dinitro and trinitrotoluenes.

For the convenience of locating the spectrum of a certain compound an index has been prepared which will give the Code No. of the compound which will facilitate finding it. A glance at the "Index" and Code Nos. will suffice to show the simplicity of locating the spectra.

The enclosed compilation includes some compounds which may not be commonly used as ingredients of explosives or propellants but may be present as impurities, may be compounds formed during the manufacturing process or may be compounds that are related to the ones actually used. Thus the compilation includes all the various mono, di and trinitrotoluene isomers. It also includes the different polymorphs of HMX. The inclusion of these substances mentioned above has been done not only for completeness, but also as a possible means of obtaining spectra band correlations.

INDEX TO INFRARED SPECTRA OF
INGREDIENTS OF PROPELLANTS AND EXPLOSIVES

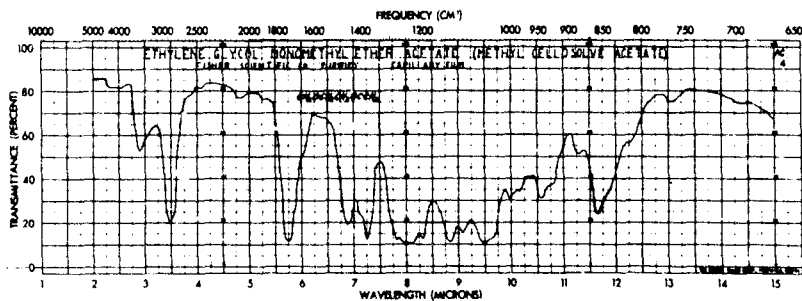
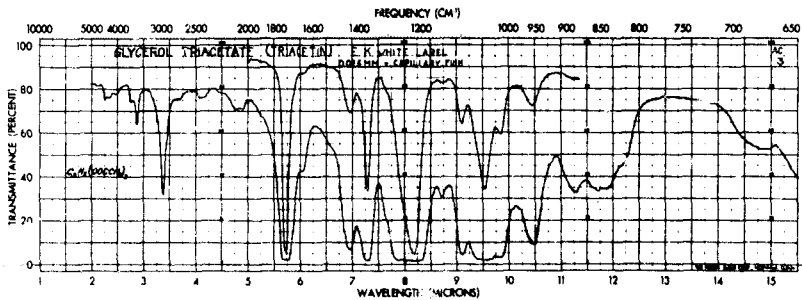
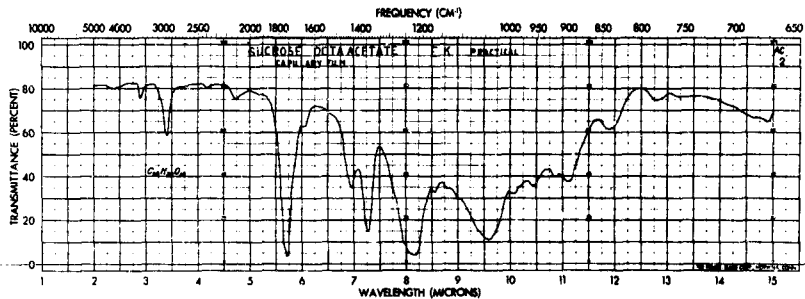
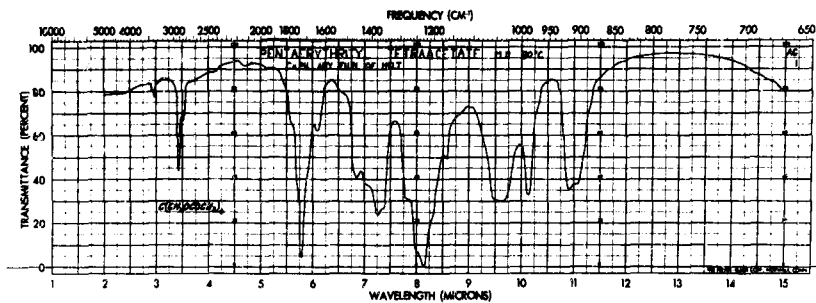
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Pentaerythrityl Tetraacetate	AC 1
Sucrose Octaacetate	AC 2
Glycerol Triacetate (Triacetin)	AC 3
Ethylene Glycol Monomethyl Ether Acetate (Methyl Cellosolve Acetate)	AC 4
Diphenylamine	Amine 1
N-Nitrosodiphenylamine	Amine 2
Para-Nitrosodiphenylamine	Amine 3
2-Nitrodiphenylamine	Amine 4
4-Nitrodiphenylamine	Amine 5
2,4-Dinitrodiphenylamine	Amine 6
2,4' Dinitrodiphenylamine	Amine 7
Diethyl Maleate	Ester 1
Di-N-Butyl-d-Tartrate	Ester 2
Diethyl-d-Tartrate	Ester 3
Diethyl Hexanedioic Acid Ester (Diethyl Adipate)	Ester 4
Dimethyl Hexanedioic Acid Ester (Dimethyl adipate)	Ester 5
Diethyl Carbonic Acid Ester (Diethyl Carbonate)	Ester 6
Triethyl Citrate	Ester 7
Diethyl Fumarate	Ester 8
Decanedioic Acid Ethyl Hexyl Ester (Ethyl Hexyl Sebacate)	Ester 9
Decanedioic Acid Dimethyl Ester (Dimethyl Sebacate)	Ester 10
N-Butyl Stearate	Ester 11
Hexanedioic Acid Dipropyl Ester (Di-N-propyl adipate)	Ester 12
Ethylene Carbonate	Ester 13
Lead Acetyl Salicylate	Metal Organo 1
Lead Salicylate	Metal Organo 2
Lead Dihydroxy Benzoate (Lead Resorcyate)	Metal Organo 3
Basic Cupric Salicylate	Metal Organo 4
Lithium Stearate	Metal Organo 5
Lead Stearate	Metal Organo 6
Magnesium Stearate	Metal Organo 7
Zinc Stearate	Metal Organo 8
Lead Meta Toluate	Metal Organo 9
Lead Rincinoate	Metal Organo 10
Mono Basic Lead Dihydroxy Benzoate (Mono Basic Lead Beta Resorcyate)	Metal Organo 11
Ferric Acetonyl Acetate	Metal Organo 12

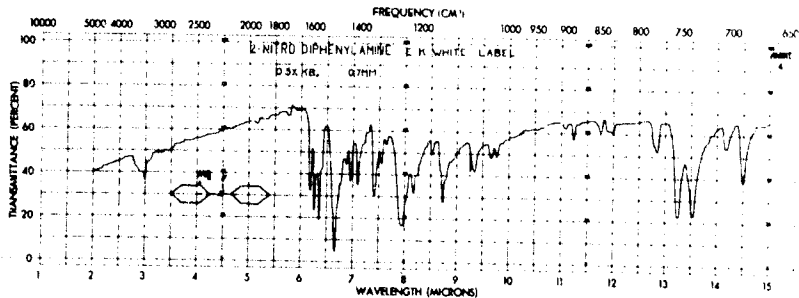
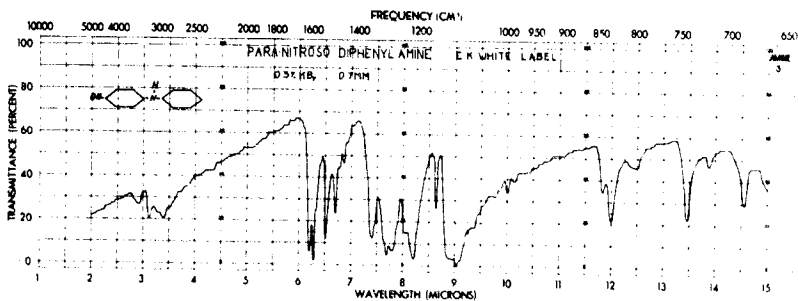
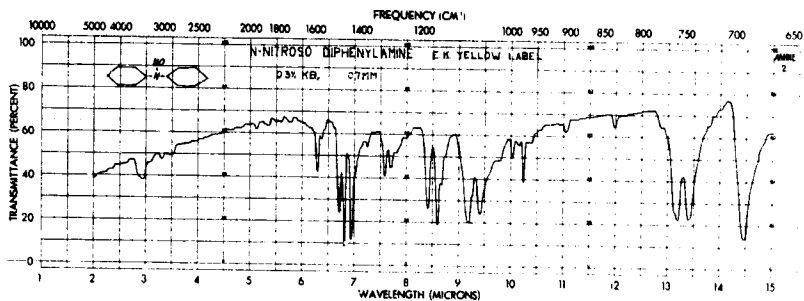
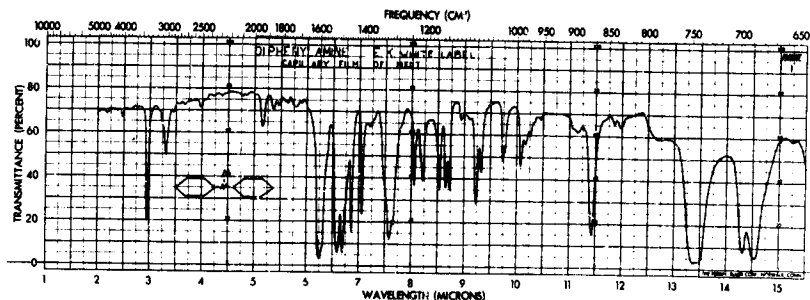
<u>NAME(S)</u>	<u>CODE</u>
Stearic Acid	Misc 1
Carbazole	Misc 2
Diphenyl Guanidine	Misc 3
Oxamide	Misc 4
Nitroguanidine	Misc 5
Methyl Nitroguanidine	Misc 6
Decaborane	Misc 7
Melamine	Misc 8
5-Aminotetrazole	Misc 9
Cyano Guanidine (Dicyandiamide)	Misc 10
Diphenyl formamide	Misc 11
Phthalide	Misc 12
Cyclotrimethylene Trinitroso Amine, "R" Salt	Misc 13
Phenazine	Misc 14
Camphor	Misc 15
Hexamethylene Tetramine	Misc 16
Beta-Resorcylic Acid	Misc 17
1,3 Dihydroxy Benzene (Resorcinol)	Misc 18
Tolyl-2,4-Diisocyanate	Misc 19
Nitroisobutyl Glycerine, "Nib" Triacrylate	Misc 20
Methyl Cellulose	Poly 1
Ethyl Cellulose	Poly 2
Cyanoethyl Cellulose	Poly 3
Ethylenedinitramine ("Edna") (Haleite)	Nitro Amine 1
Methylenedinitramine, "Medina"	Nitro Amine 2
1,3,5 Triazine Hexahydro 1,3,5-Trinitro (RDX)	Nitro Amino 3
Cyclotetramethylenetetranitramine (Beta HMX)	Nitro Amino 4
Cyclotetramethylenetetranitramine (Alpha HMX)	Nitro Amino 5
Cyclotetramethylenetetranitramine (Gamma HMX)	Nitro Amino 6
N-Methyl-N, 2,4,6-Tetranitroaniline (Tetryl)	Nitro Amino 7
Monomethyl Haleite	Nitro Amino 7
Dimethyl Haleite	Nitro Amino 8
M-Nitroanisole	Nitro Amino 9
P-Nitroanisole	Nitro Arom 1
2,4-Dinitroanisole	Nitro Arom 2
2,4,6-Trinitroanisole	Nitro Arom 3
Nitrobenzene	Nitro Arom 4
M-Dinitrobenzene	Nitro Arom 5
P-Dinitrobenzene	Nitro Arom 6
1,3,5-Trinitrobenzene	Nitro Arom 7
2-Nitroethylbenzene	Nitro Arom 8
4-Nitroethylbenzene	Nitro Arom 9
2,4-Dinitroethylbenzene	Nitro Arom 10
2,4,6-Trinitroethylbenzene	Nitro Arom 11
	Nitro Arom 12

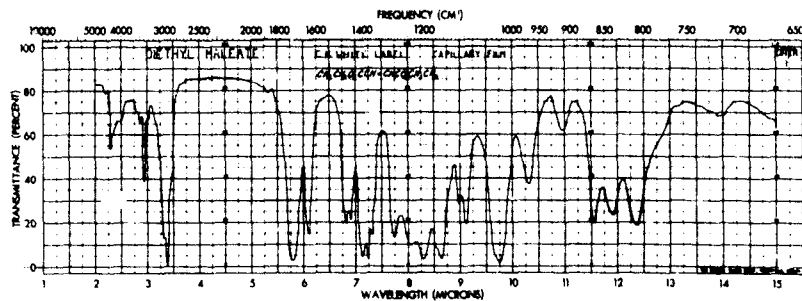
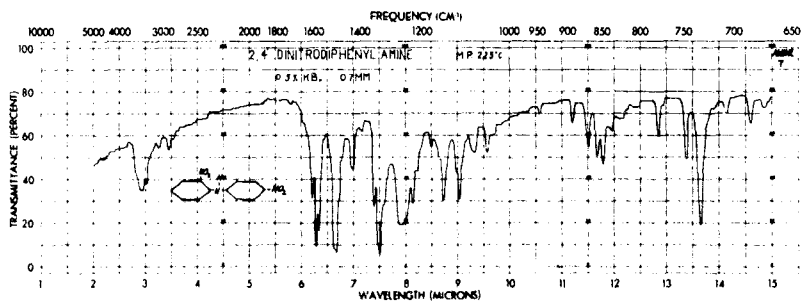
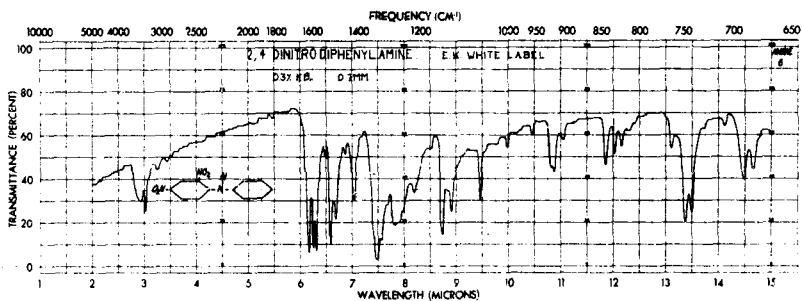
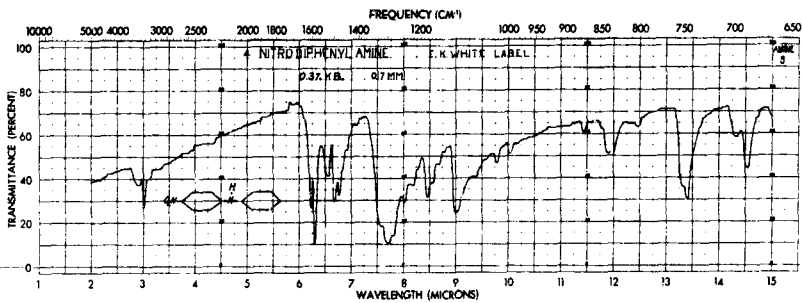
<u>NAME(S)</u>	<u>CODE</u>
Alpha Nitronaphthalene	Nitro Arom 13
1,5-Dinitronaphthalene	Nitro Arom 14
1,8 Dinitronaphthalene	Nitro Arom 15
1,3,8-Trinitronaphthalene	Nitro Arom 16
2-Nitrotoluene	Nitro Arom 17
3-Nitrotoluene	Nitro Arom 18
4-Nitrotoluene	Nitro Arom 19
2,3-Dinitrotoluene	Nitro Arom 20
2,4-Dinitrotoluene	Nitro Arom 21
2,5-Dinitrotoluene	Nitro Arom 22
2,6-Dinitrotoluene	Nitro Arom 23
3,4-Dinitrotoluene	Nitro Arom 24
3,5-Dinitrotoluene	Nitro Arom 25
2,3,4-Trinitrotoluene	Nitro Arom 26
2,3,5-Trinitrotoluene	Nitro Arom 27
2,3,6 Trinitrotoluene	Nitro Arom 28
2,4,5 Trinitrotoluene	Nitro Arom 29
2,4,6-Trinitrotoluene	Nitro Arom 30
3,4,5-Trinitrotoluene	Nitro Arom 31
2-Nitrobenzoic Acid	Nitro Arom 32
3-Nitrobenzoic Acid	Nitro Arom 33
4-Nitrobenzoic Acid	Nitro Arom 34
2,4 Dinitrobenzoic Acid	Nitro Arom 35
3,5 Dinitrobenzoic Acid	Nitro Arom 36
2,4,6-Trinitrobenzoic Acid	Nitro Arom 37
Diaminotrinitrobenzene	Nitro Arom 38
1,Nitro Carbazole	Nitro Arom 39
3,Nitro Carbazole	Nitro Arom 40
1,2,6,8 Tetranitrocarbazole	Nitro Arom 41
2,4,5,7 Tetranitrocarbazole	Nitro Arom 42
Para-Nitro-N-Methyl Aniline	Nitro Arom 43
1,2,4-Butanetriol trinitrate	Organo Nitrate 1
Nitrocellulose	Organo Nitrate 2
Ethyleneglycoldinitrate	Organo Nitrate 3
Diethyleneglycoldinitrate (DEGN)	Organo Nitrate 4
Triethyleneglycol dinitrate (TEGN)	Organo Nitrate 5
Mannitol Hexanitate	Organo Nitrate 6
Metrioltrinitrate	Organo Nitrate 7
Glycerol Trinitrate (Nitroglycerine)	Organo Nitrate 8
Pentaerythritol Tetranitrate (PETN)	Organo Nitrate 9
Pentaerythritol dinitrate (PEDN)	Organo Nitrate 10
Pentaerythritol trinitrate (Petrin)	Organo Nitrate 11
Pentaerythritol trinitrate (Petrin) Acrylate	Organo Nitrate 12
Tetramethylolcyclopentanone Tetranitrate (Fivonite)	Organo Nitrate 13
Tetramethylolcyclohexanol pentanitate (Sixolite)	Organo Nitrate 14
Dipentaerythritolhexanitate	Organo Nitrate 15

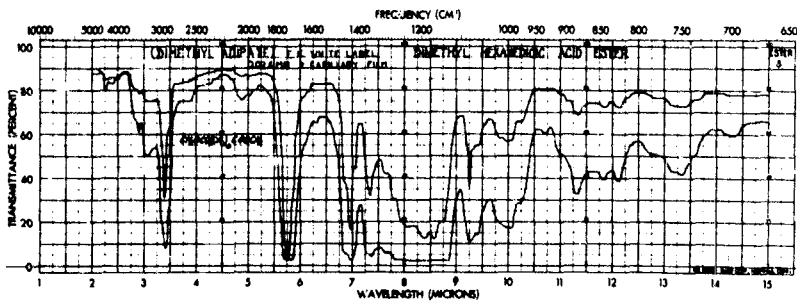
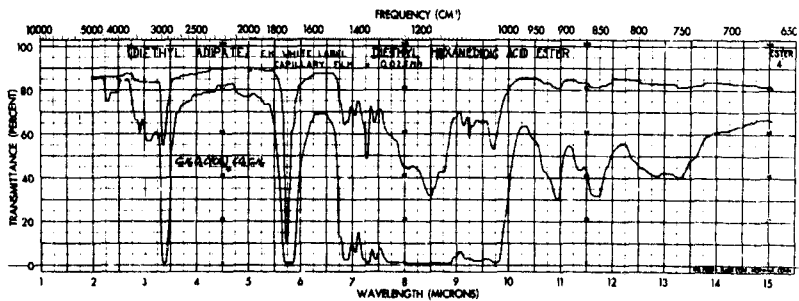
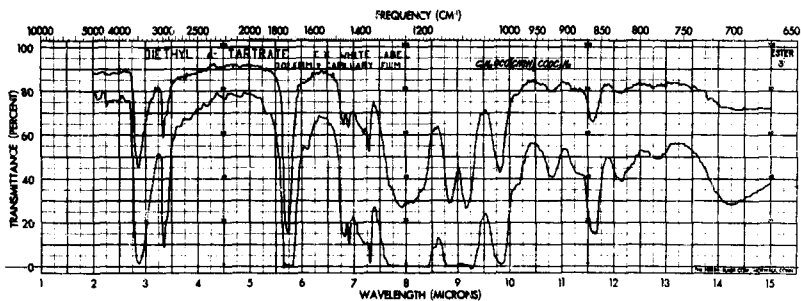
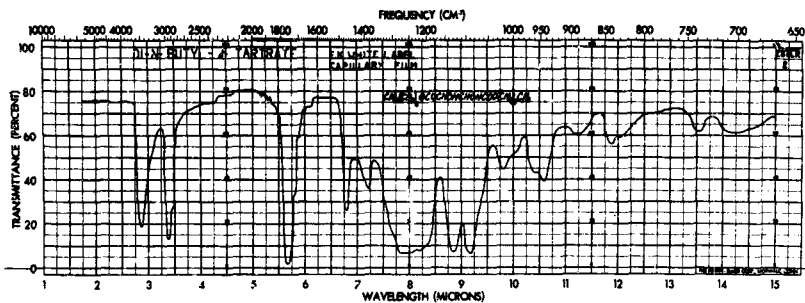
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Triptaerythritolactonitrate	Organo Nitrate 16
Propyleneglycoldinitrate	Organo Nitrate 17
Nitroisobutylglycerine "NIB" dinitrate	Organo Nitrate 18
Nitroisobutylglycerine "NIB" Trinitrate	Organo Nitrate 19
Nitroisobutylglycerine "NIB" dinitrate acrylate	Organo Nitrate 20
Nitroisobutylglycerine "NIB" dinitrate polyacrylate	Organo Nitrate 21
Trioctylphosphate	Phos 1
Triphenylphosphate	Phos 2
Tri-o-tolylphosphate	Phos 3
Tri-cresylphosphate	Phos 4
Tri-p-cresylphosphate	Phos 5
Dimethylphthalate	Phth 1
Diethylphthalate	Phth 2
Dibutylphthalate	Phth 3
Diisobutylphthalate	Phth 4
Di-N-Amylphthalate	Phth 5
Diisoamylphthalate	Phth 6
Dicaprylphthalate	Phth 7
Dicyclohexylphthalate	Phth 8
Diphenylphthalate	Phth 9
Dibenzylphthalate	Phth 10
Diisooctylphthalate	Phth 11
Di-N-octylphthalate	Phth 12
Di-2-Ethylhexylphthalate	Phth 13
Potassium perchlorate	Salt 1
Ammonium perchlorate	Salt 2
Ammonium Nitrate	Salt 3
Diammonium haleite	Salt 4
Ammonium picrate	Salt 5
Guanidine perchlorate	Salt 6
Guanidine nitrate	Salt 7
Triaminoguanidine nitrate	Salt 8
Triaminoguanidine picrate	Salt 9
Triaminoguanidine perchlorate	Salt 10
Triaminoguanidine haleite "ethylene dinitramine"	Salt 11
Ethylenediamine dinitrate	Salt 12
Urea nitrate	Salt 13
Hydrazine nitrate	Salt 14
Hexamethylenetetramine dinitrate	Salt 15
S-Diethyldiphenylurea	Urea 1
(Ethyl centralite)	
S-Dimethyldiphenylurea	Urea 2
(Methyl centralite)	
AS-Dimethyldiphenylurea	Urea 3
(S)N,N' Di-p-Tolylurea	Urea 4
Monophenylurea	Urea 5
N,N-Diphenylurea	Urea 6
N,N' Diphenylurea	Urea 7
Carbamic Acid Ethylphenyl ethyl ester	
(N, Ethyl-N-Phenyl Urethane)	Urethol

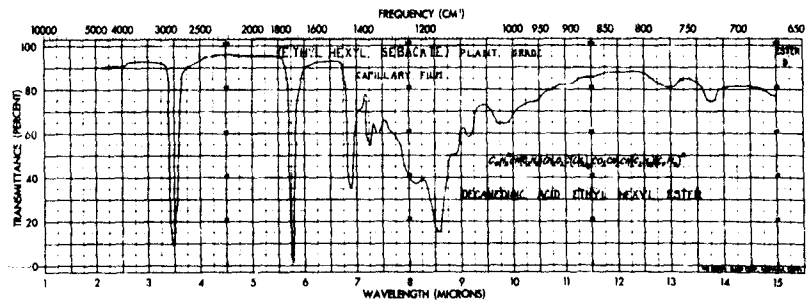
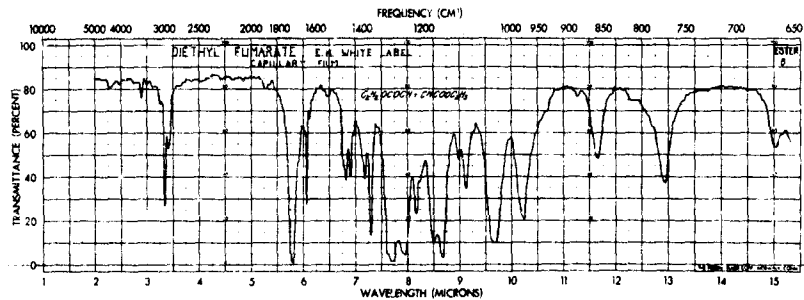
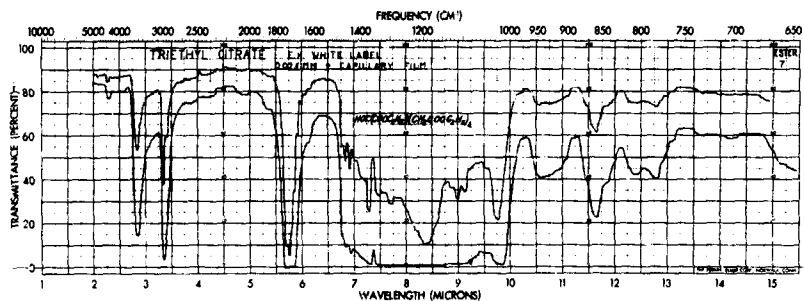
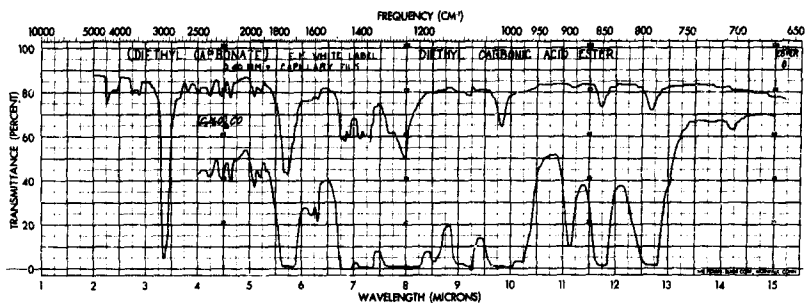
<u>NAME(S)</u>	<u>CODE</u>
Carbamic Acid diphenyl ethyl ester (diphenylurethane)	Ureth 2
Carbanilic Acid Ethyl Ester (Phenylurethane)	Ureth 3
Carbamic Acid-o-tolyl ethyl ester (o-tolylurethane)	Ureth 4

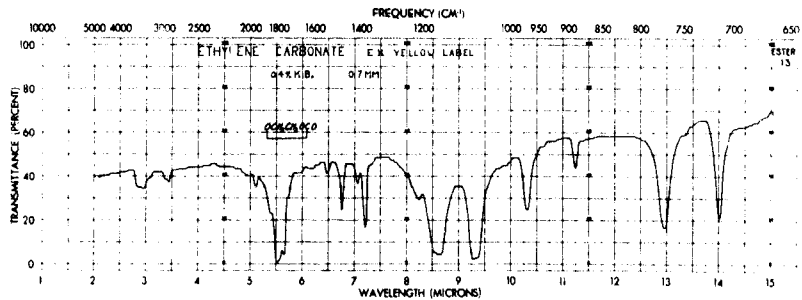
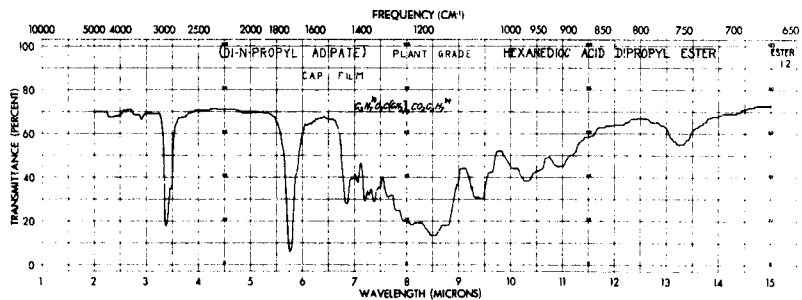
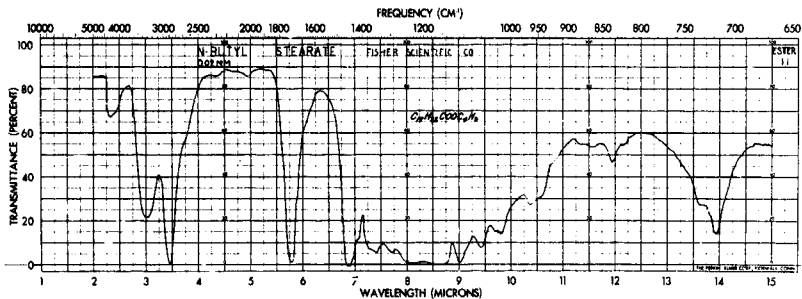
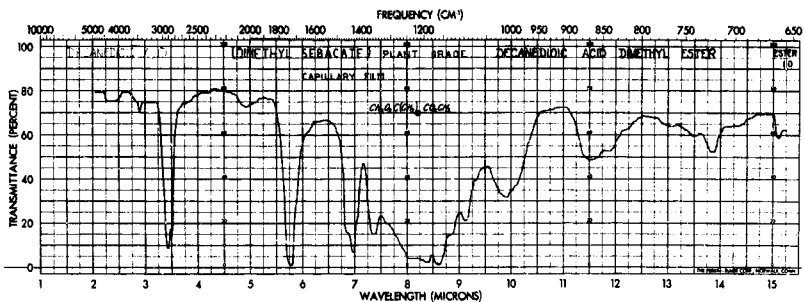


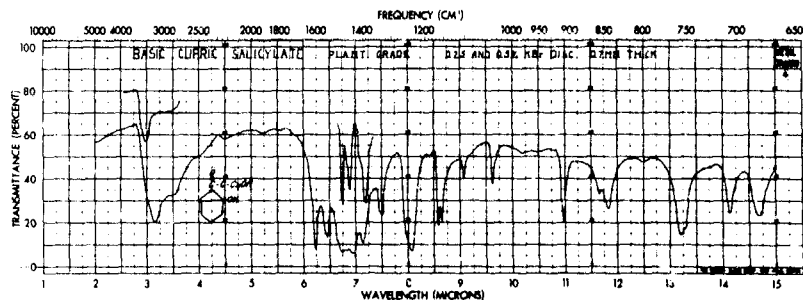
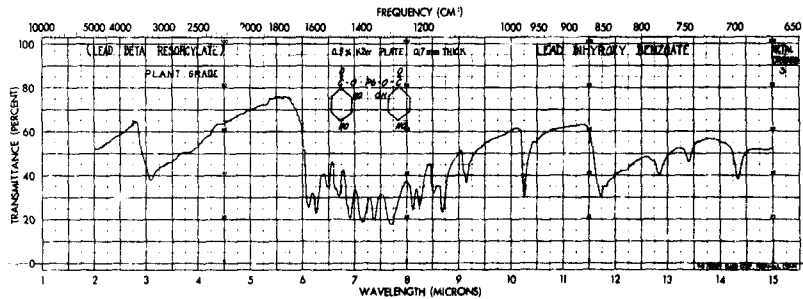
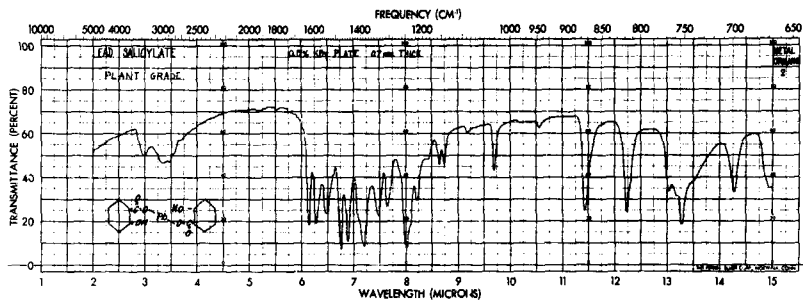
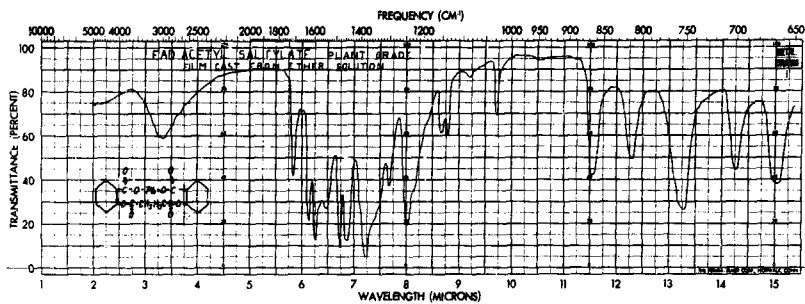


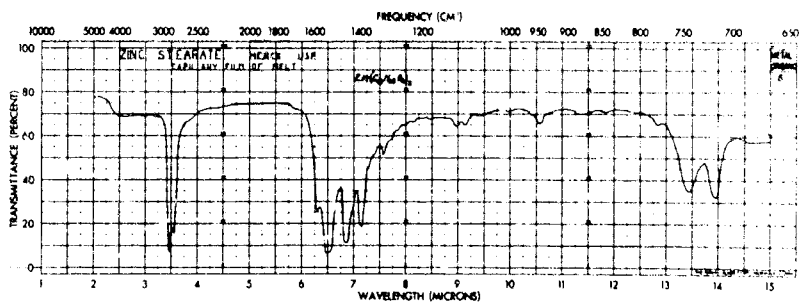
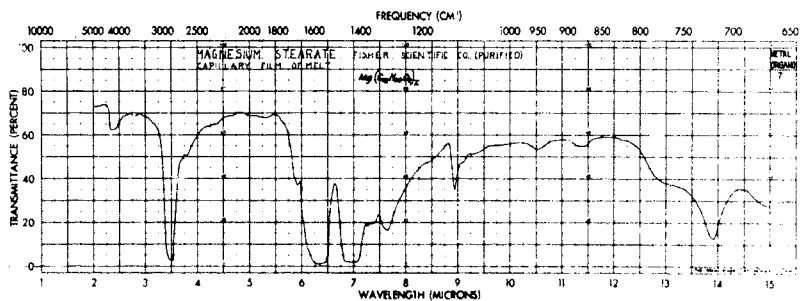
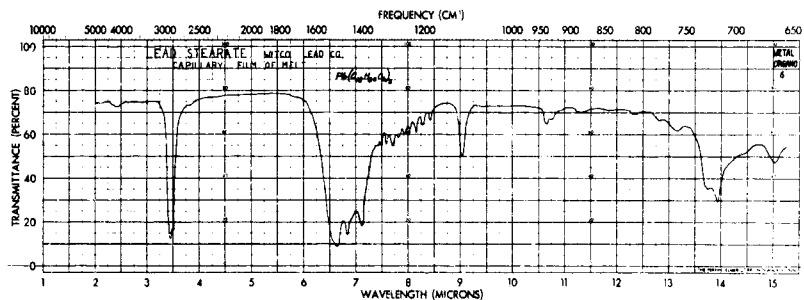
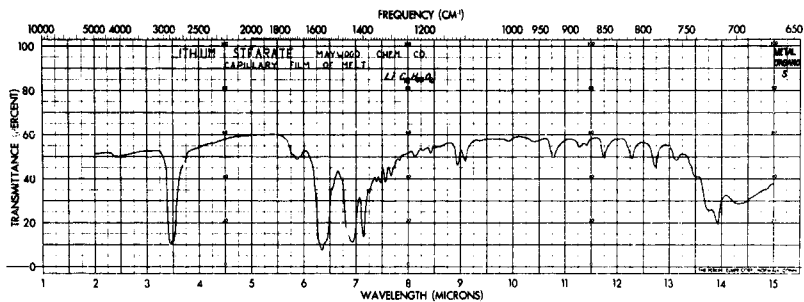


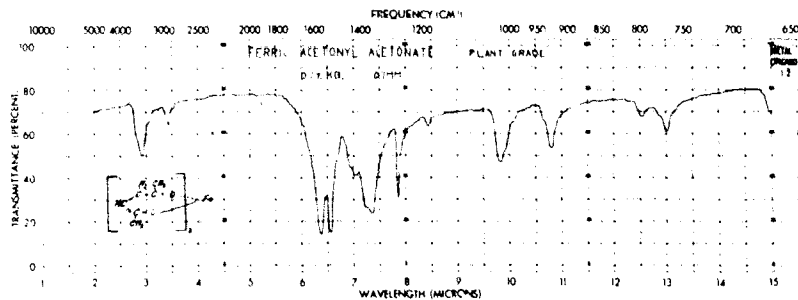
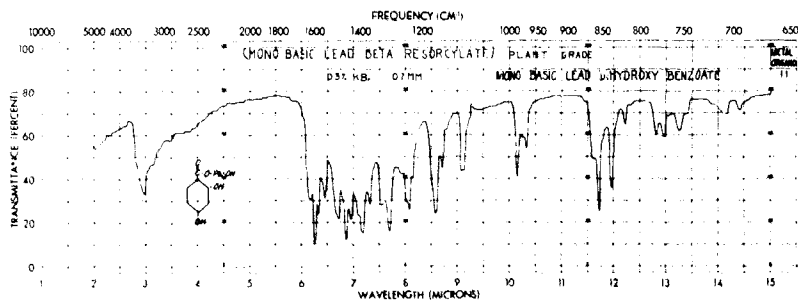
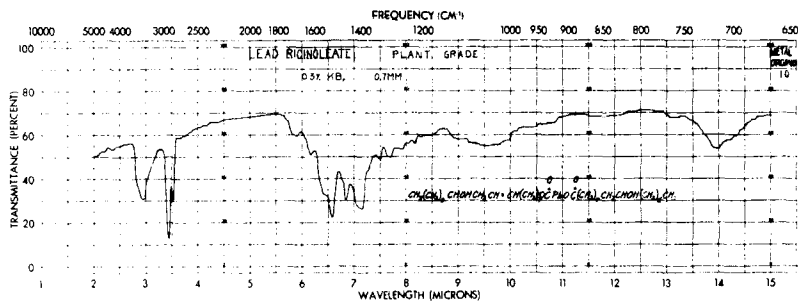
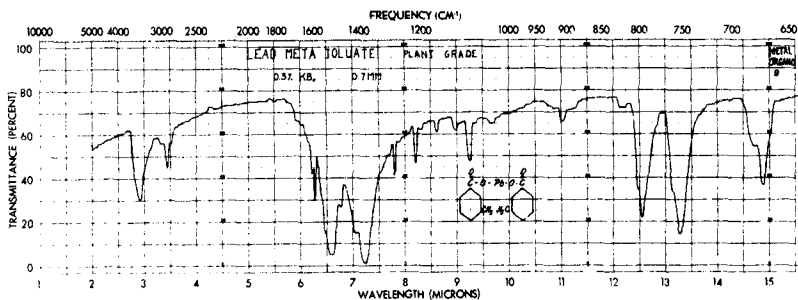


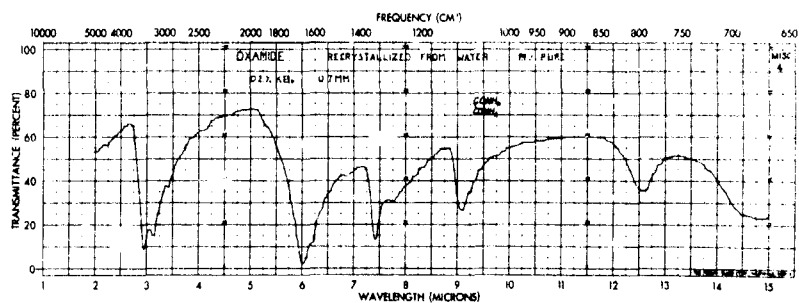
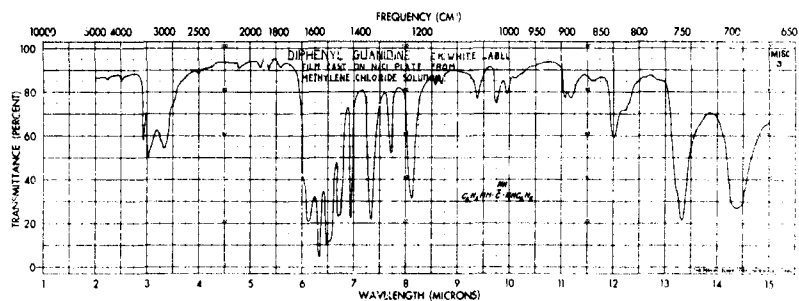
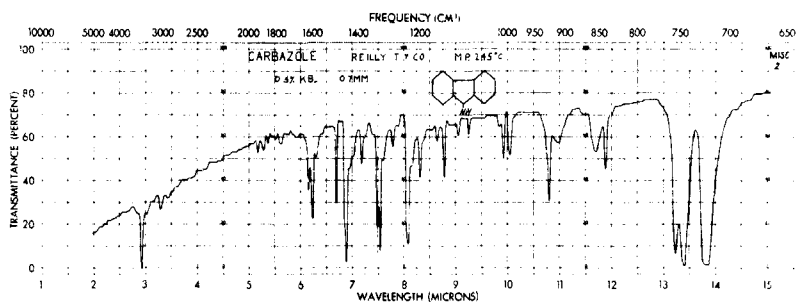
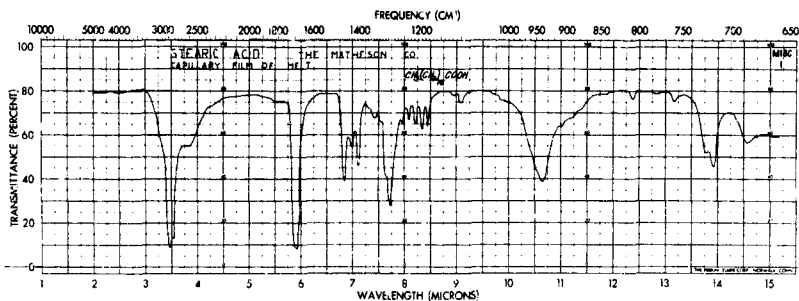


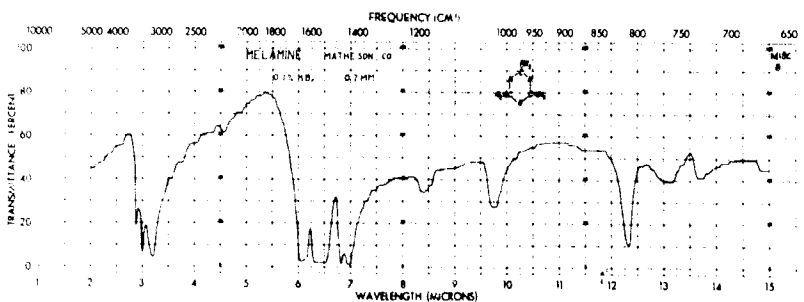
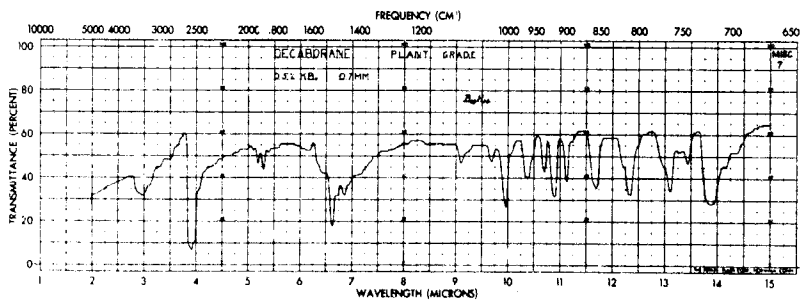
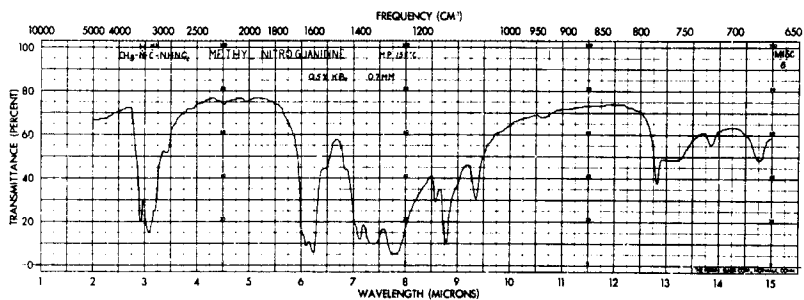
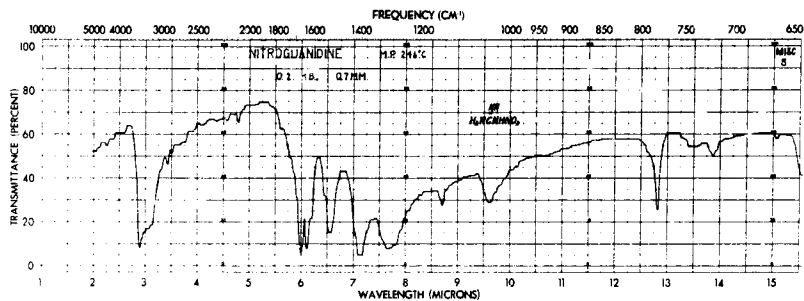


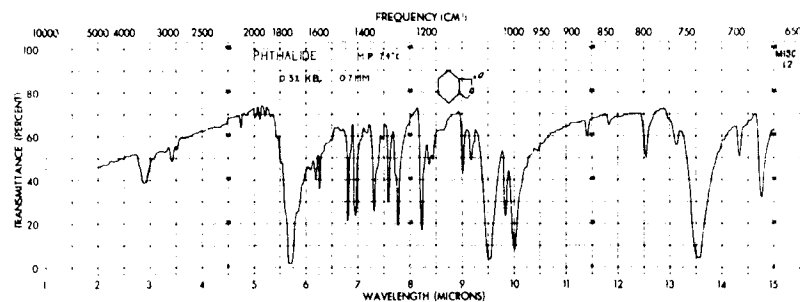
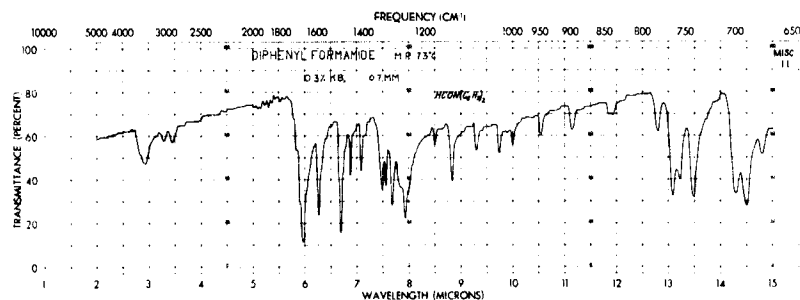
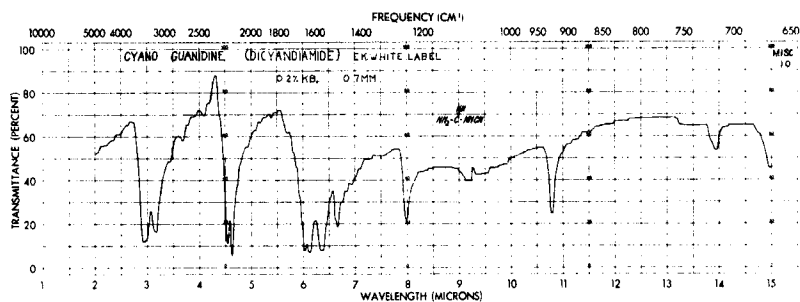
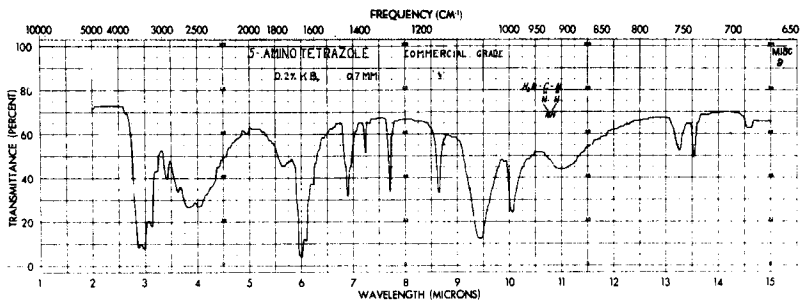




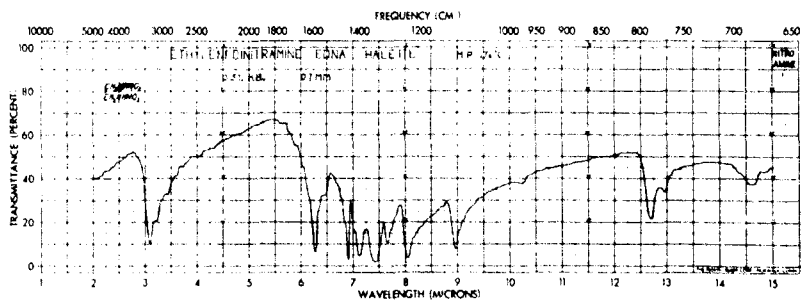
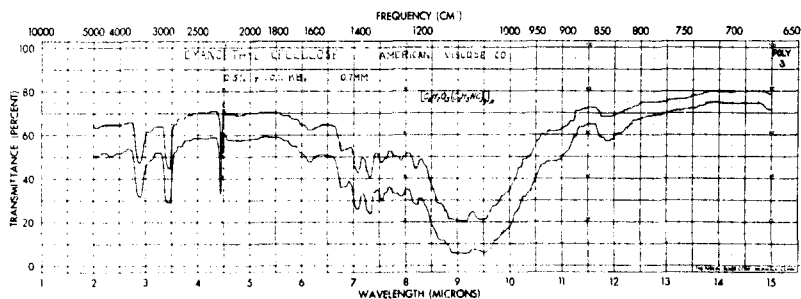
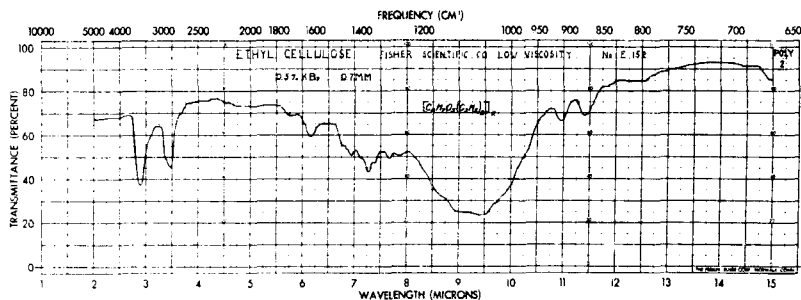
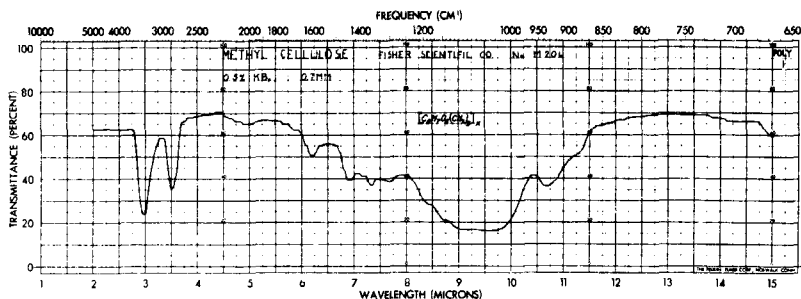


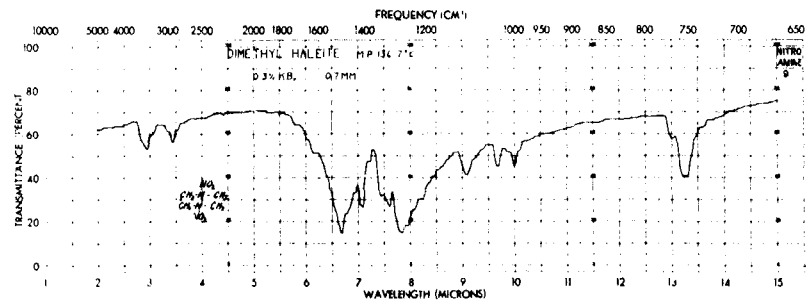
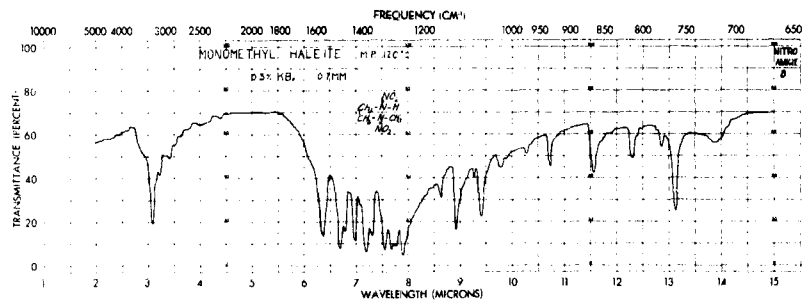
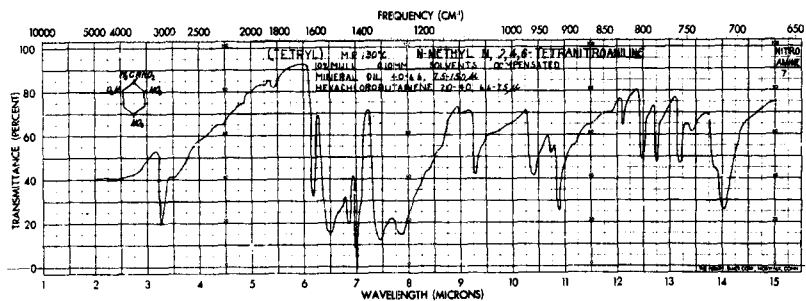
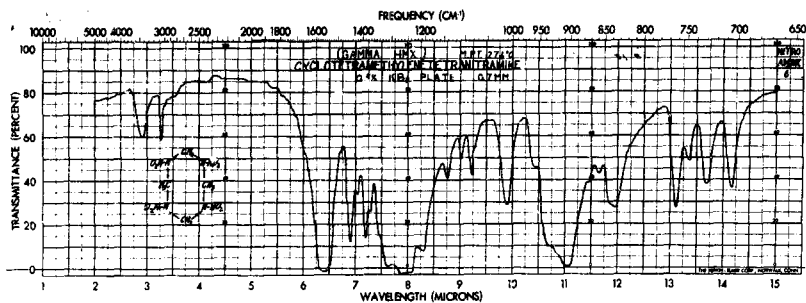


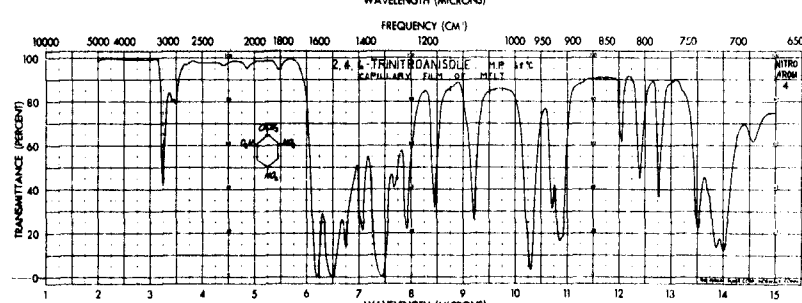


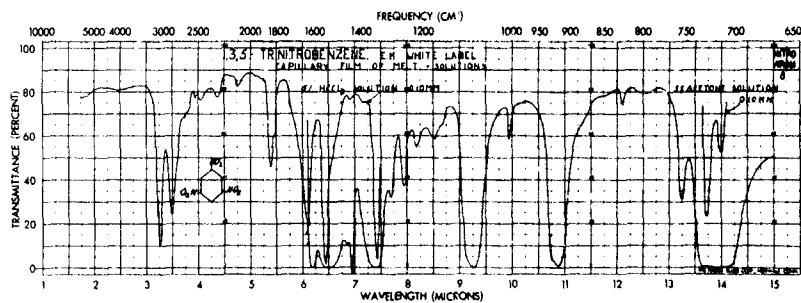
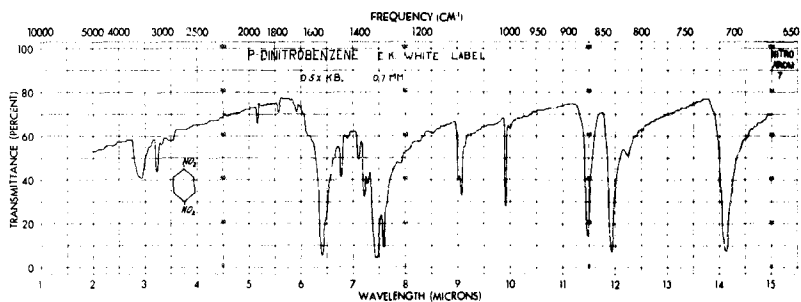
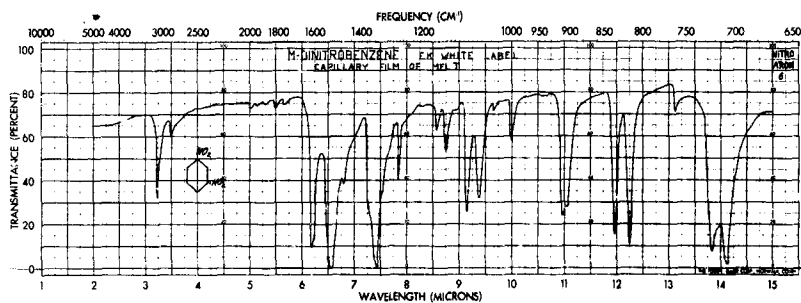
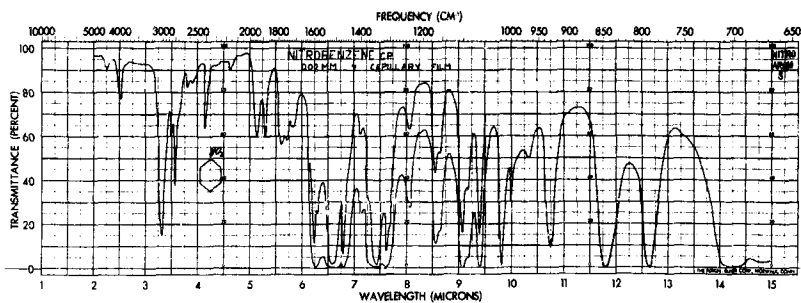


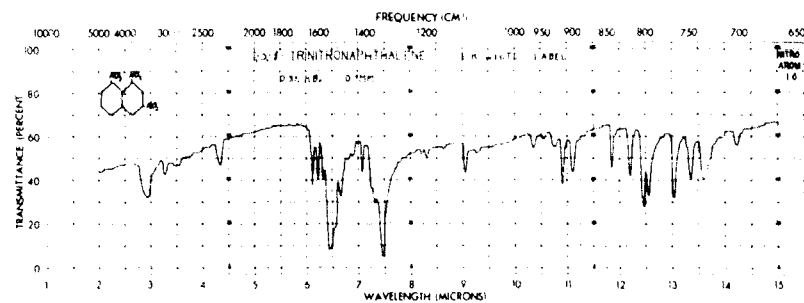
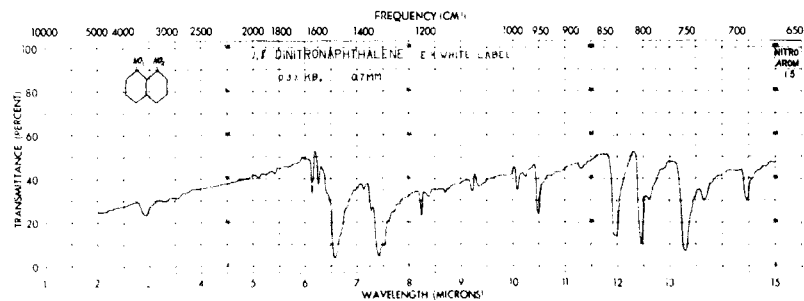
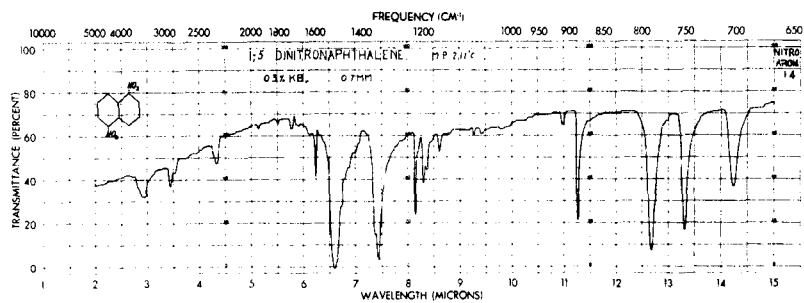
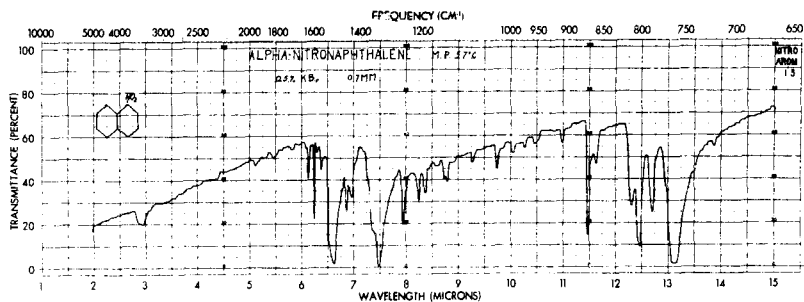


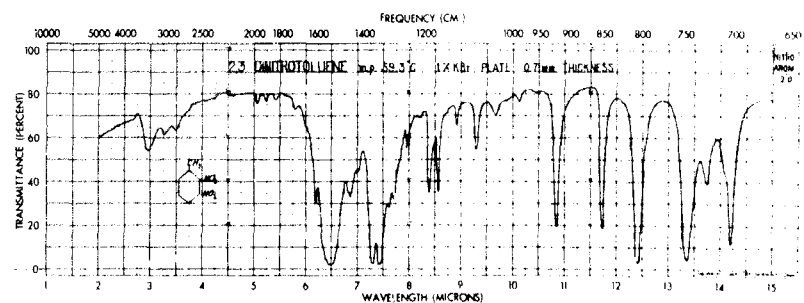
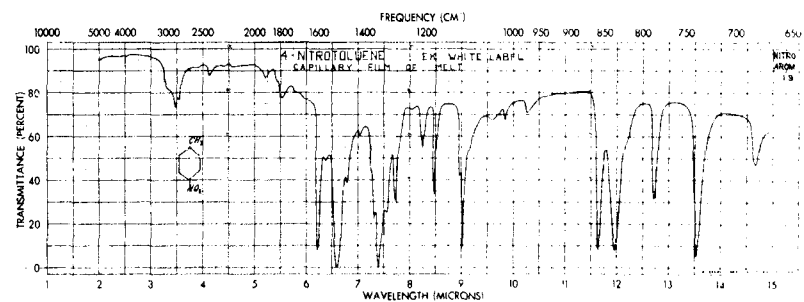
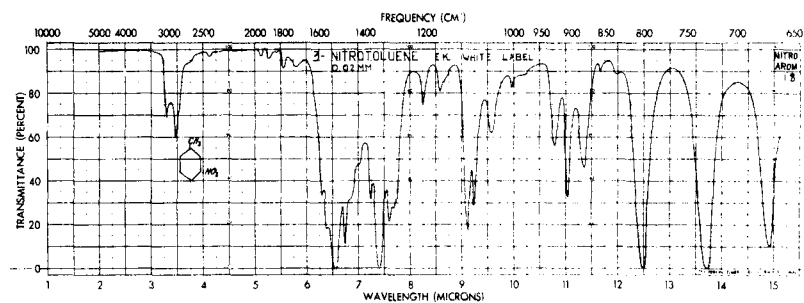
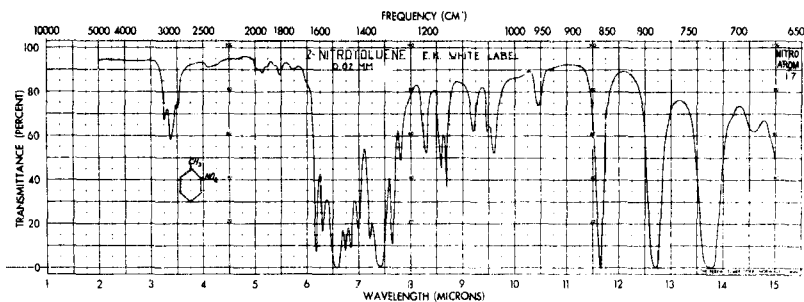


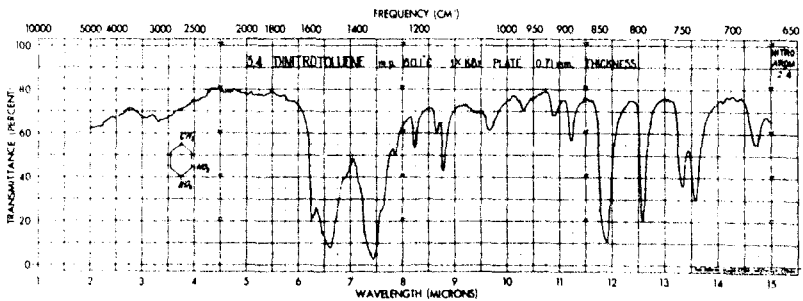
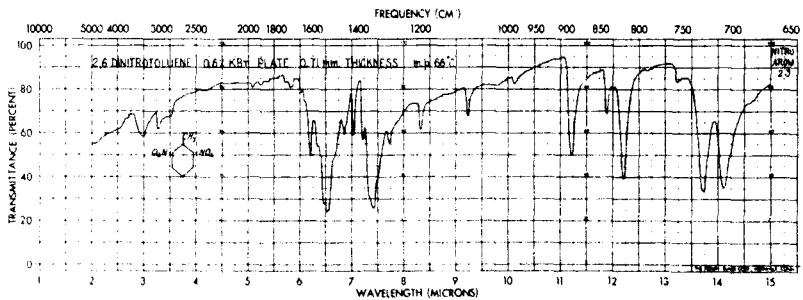
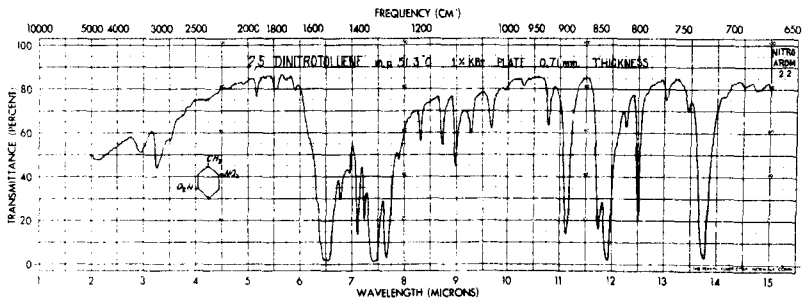
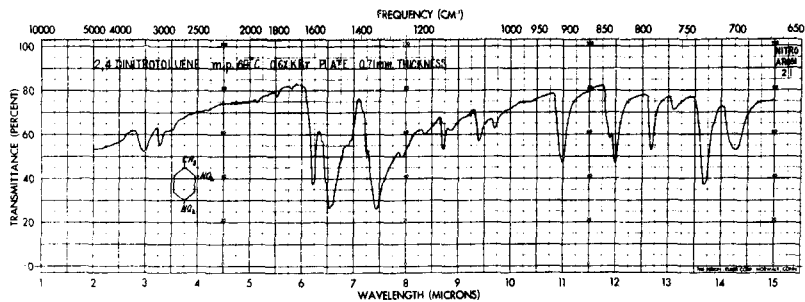


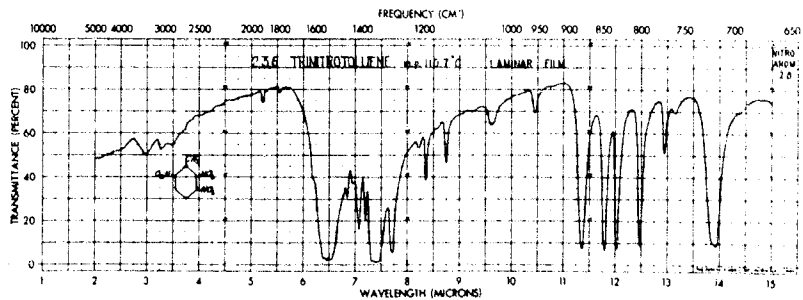
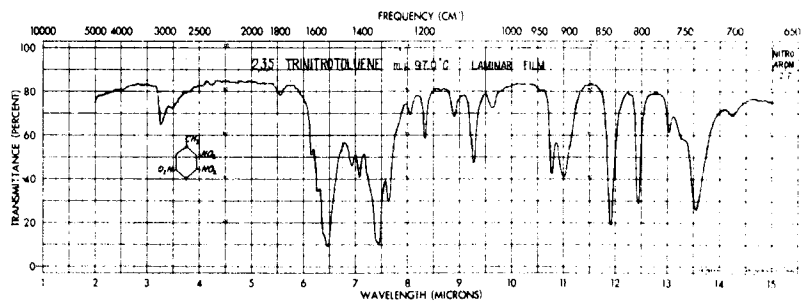
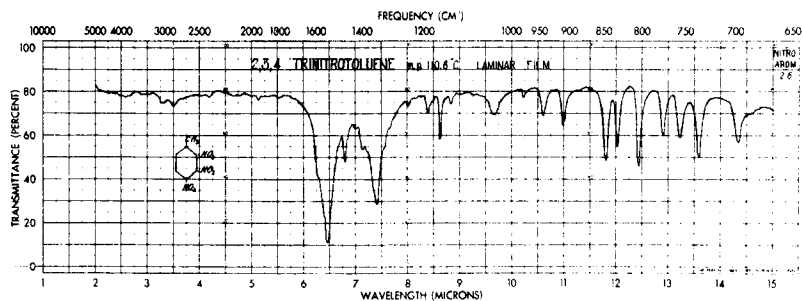
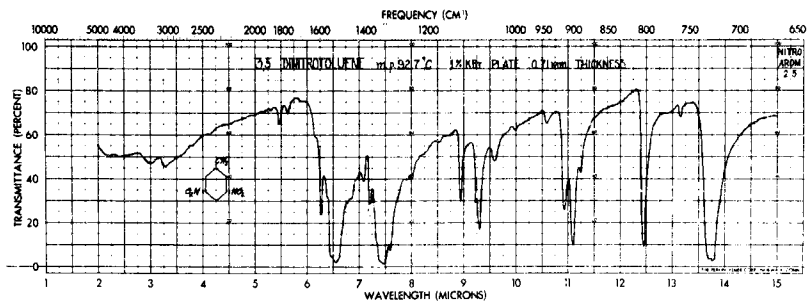


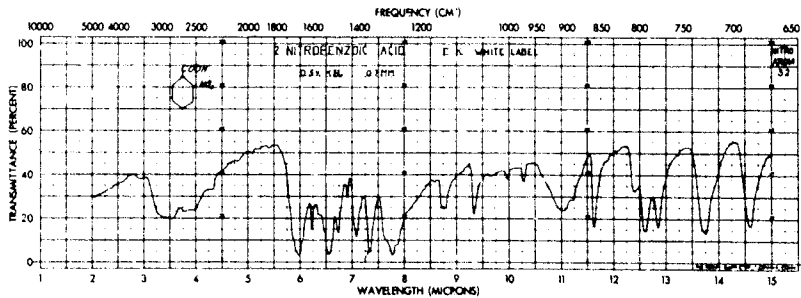
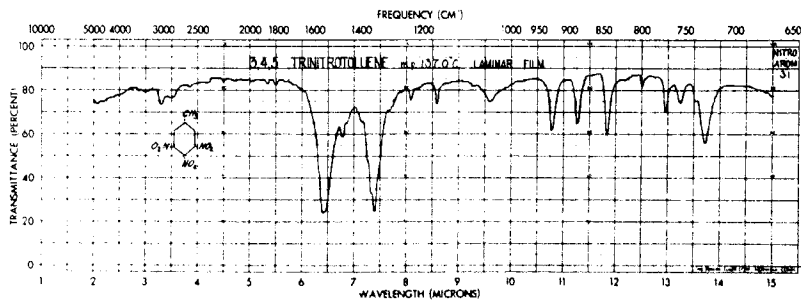
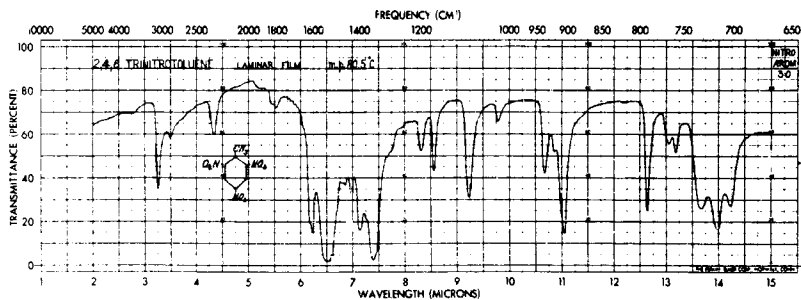
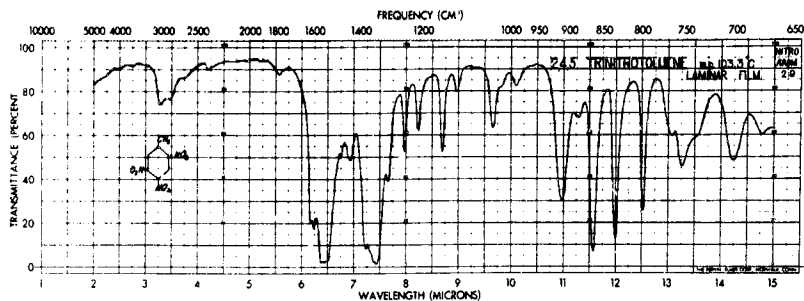


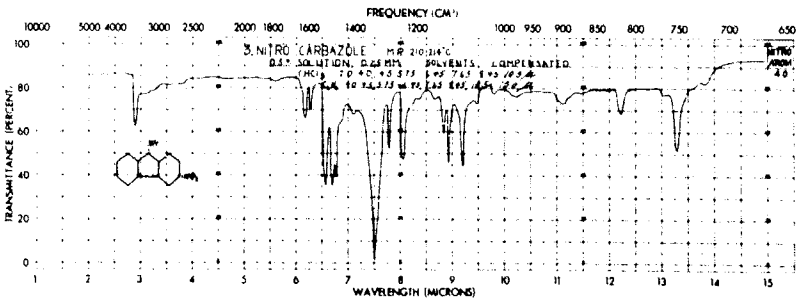


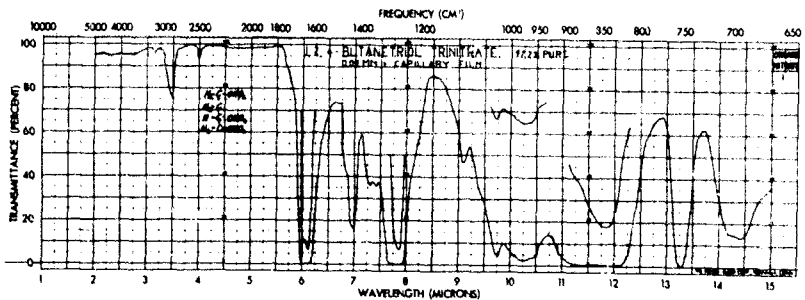
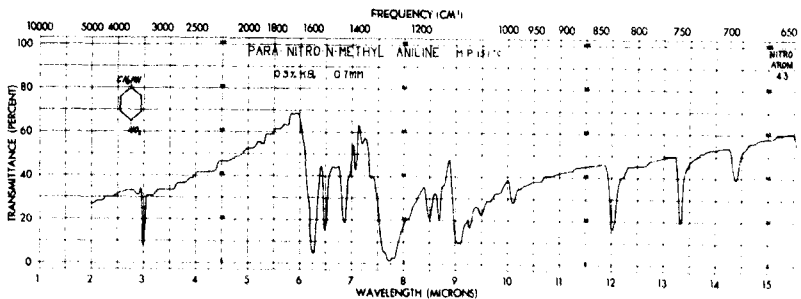
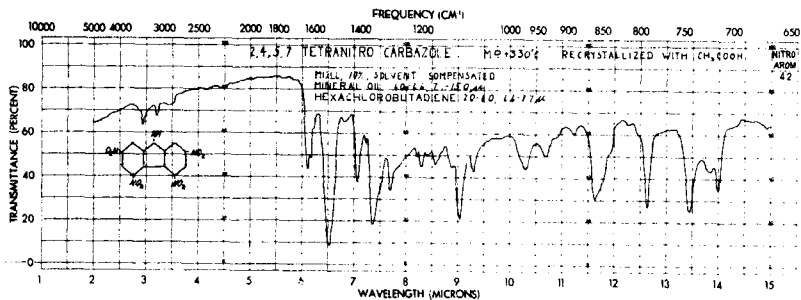
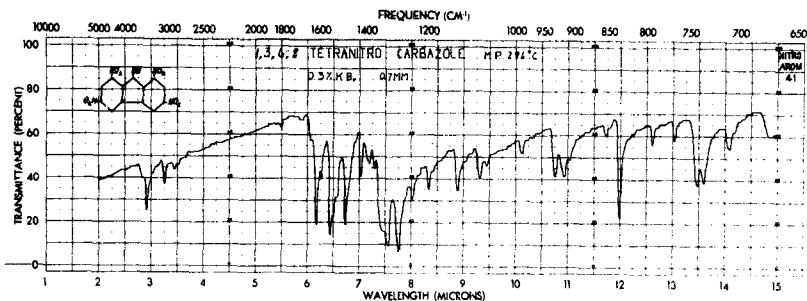


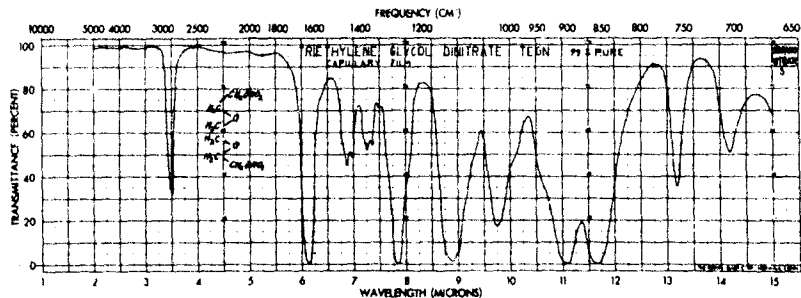
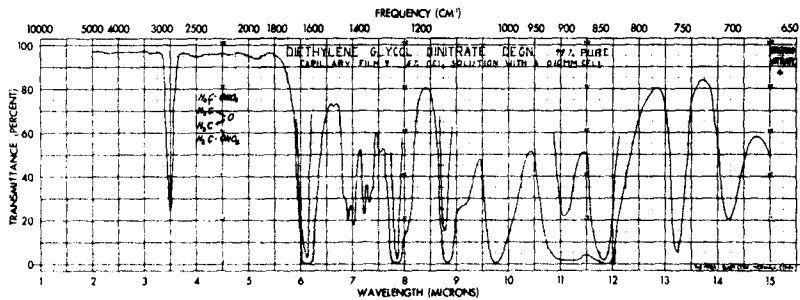
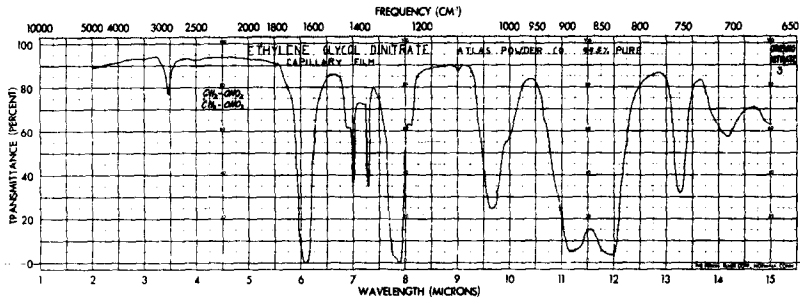
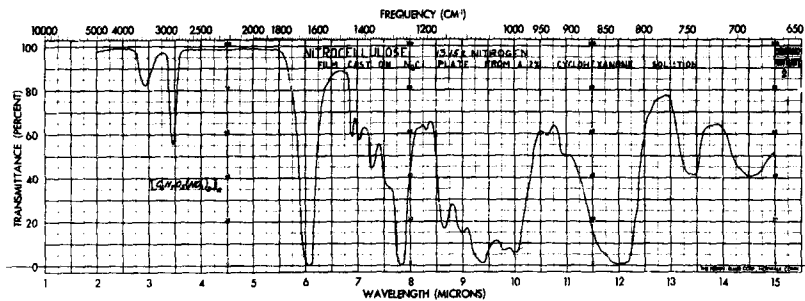


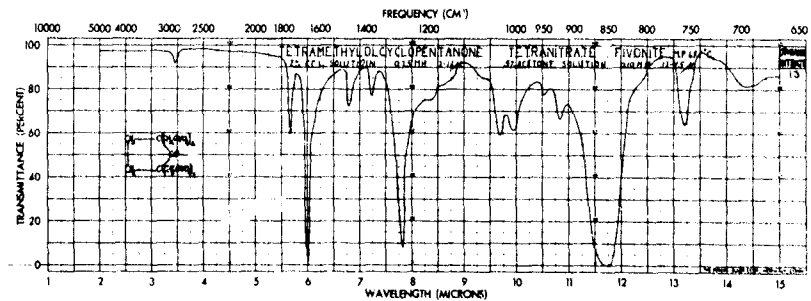
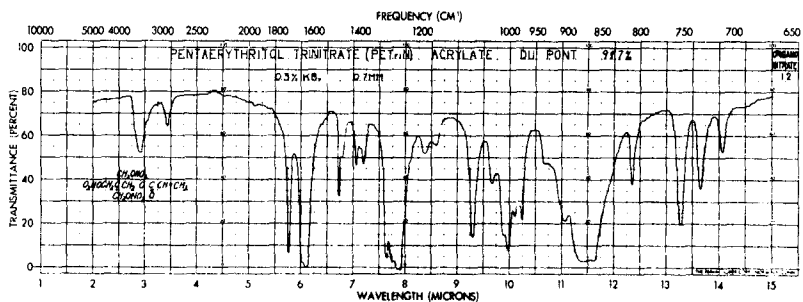
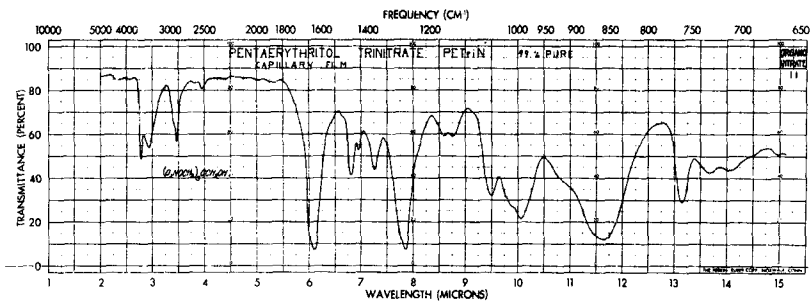
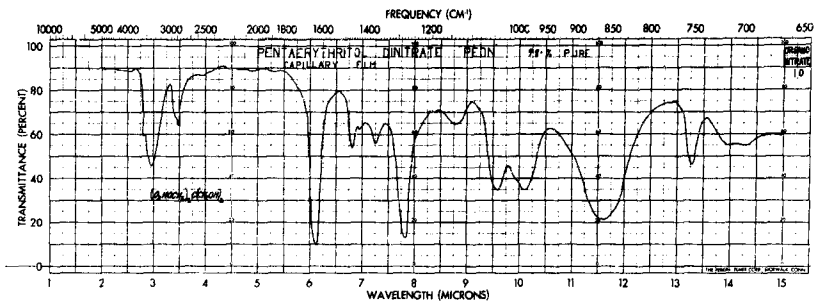


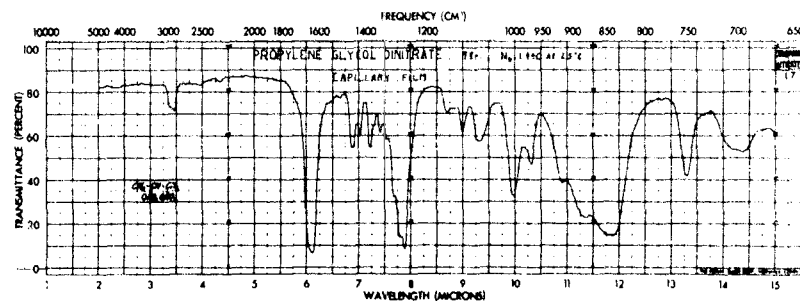
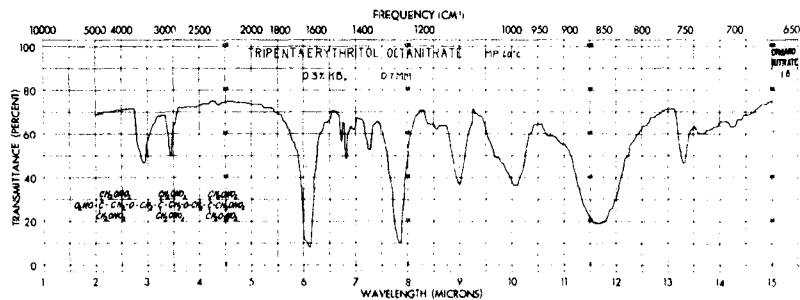
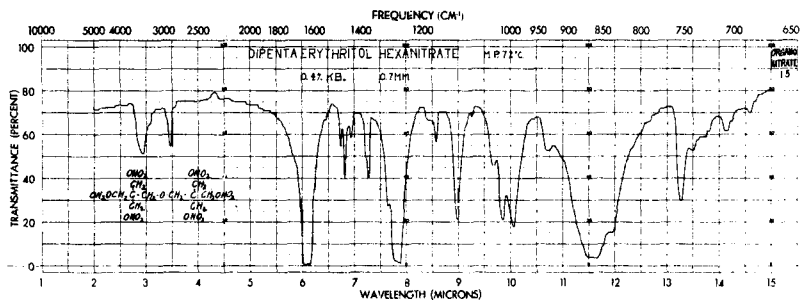
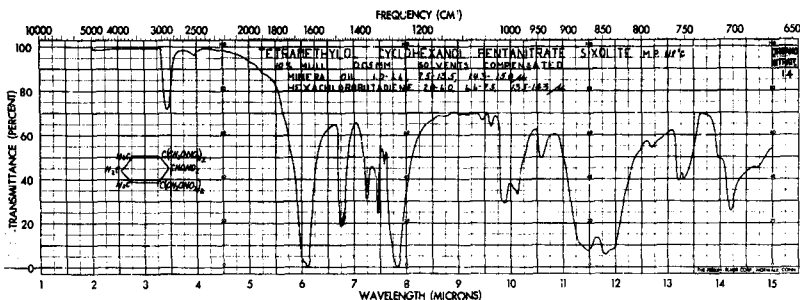


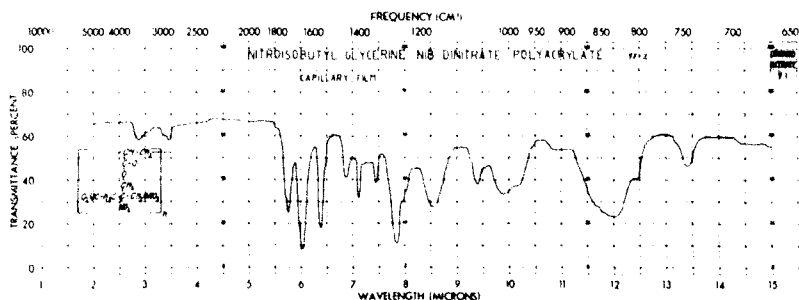


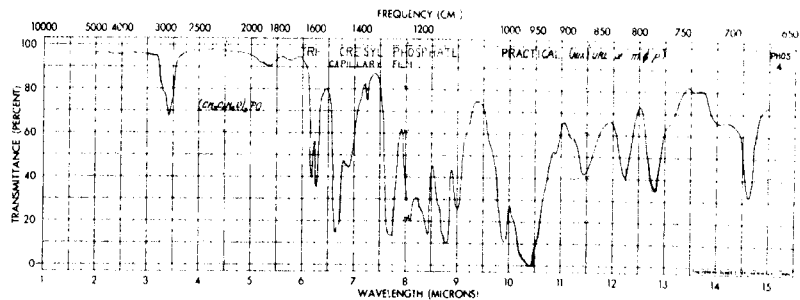
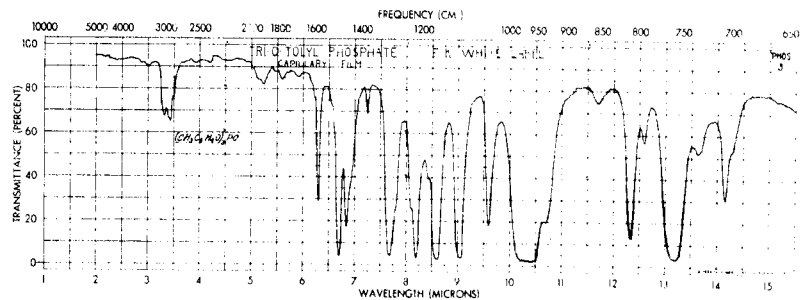
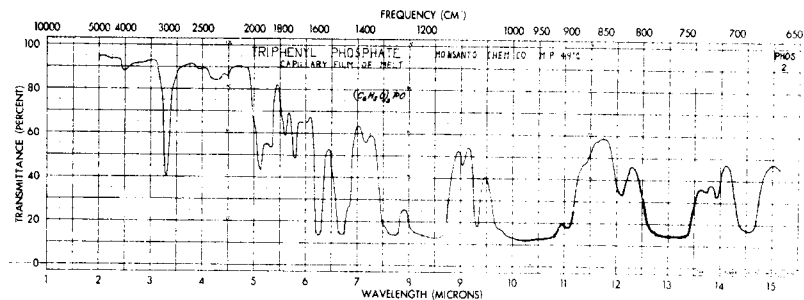
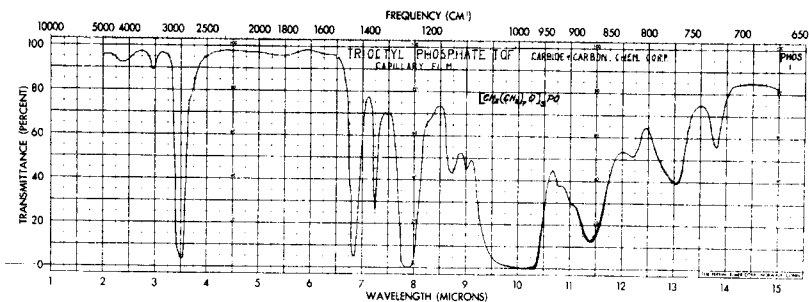


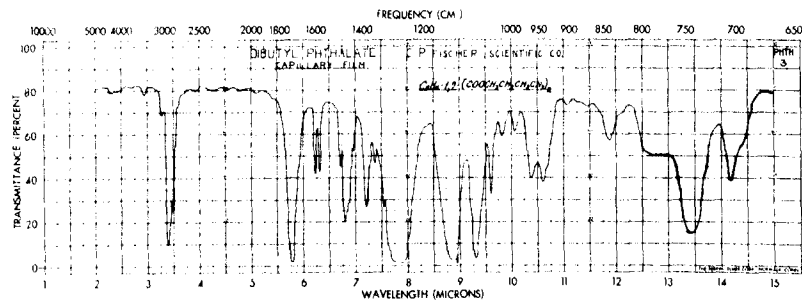
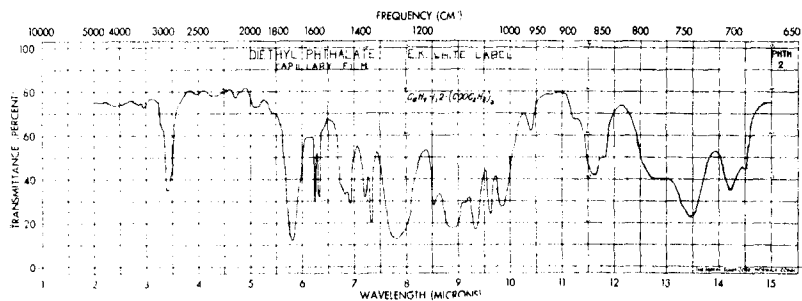
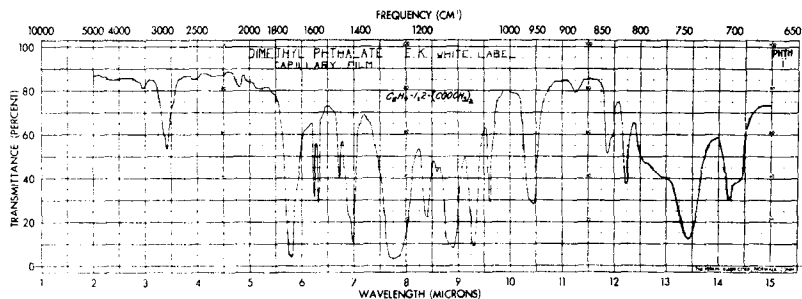
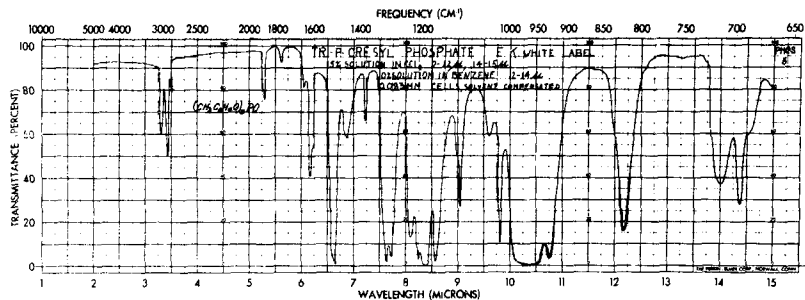


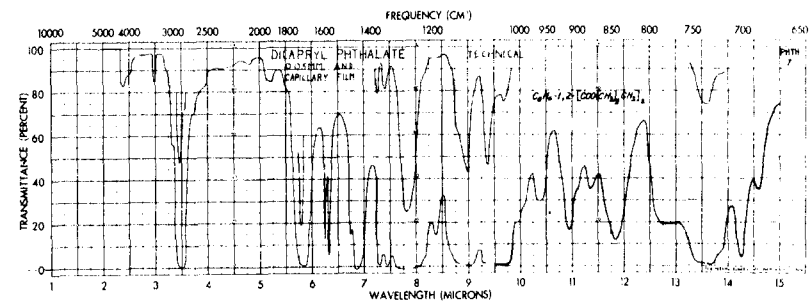
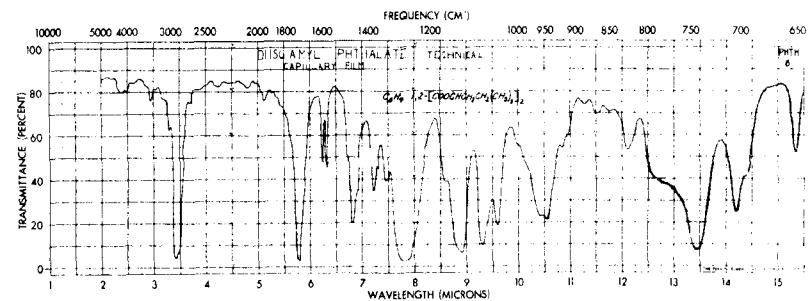
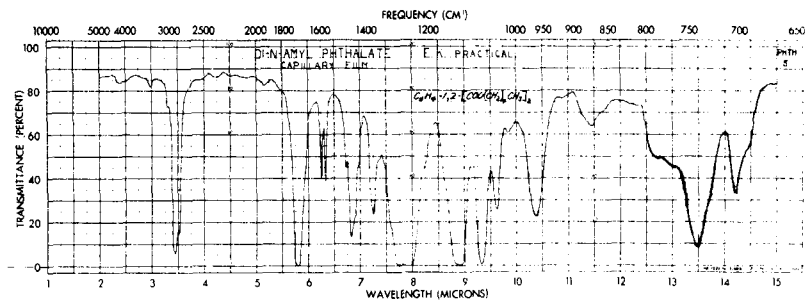
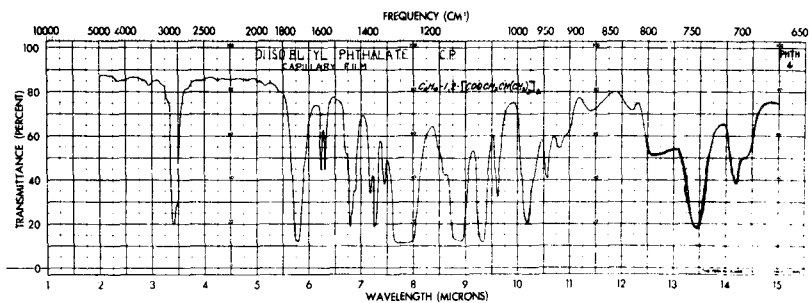


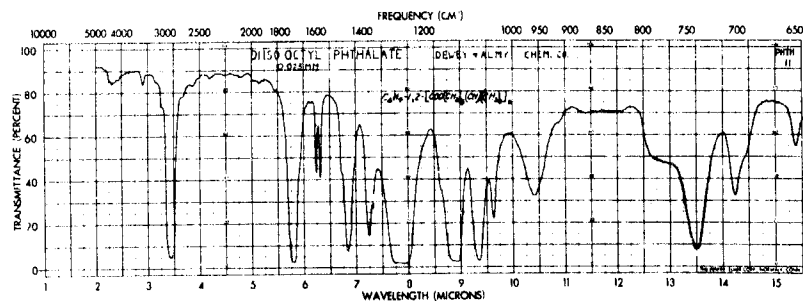
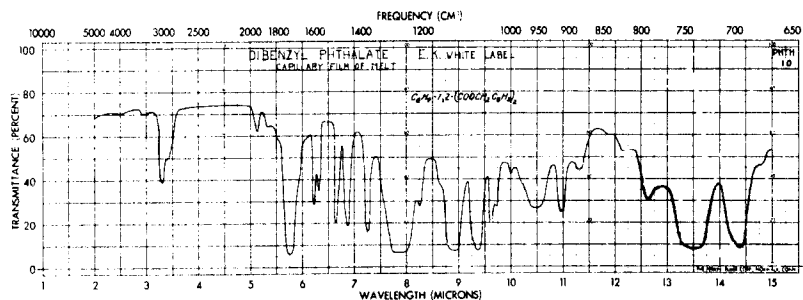
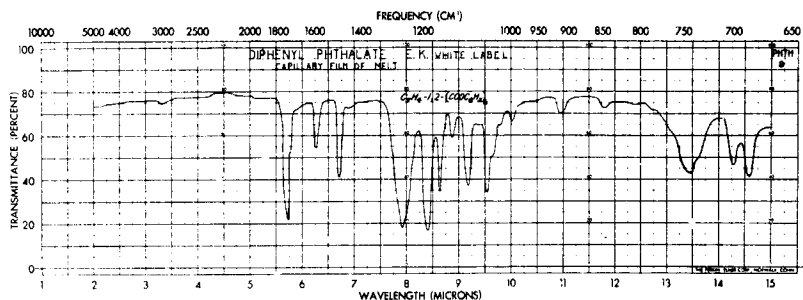
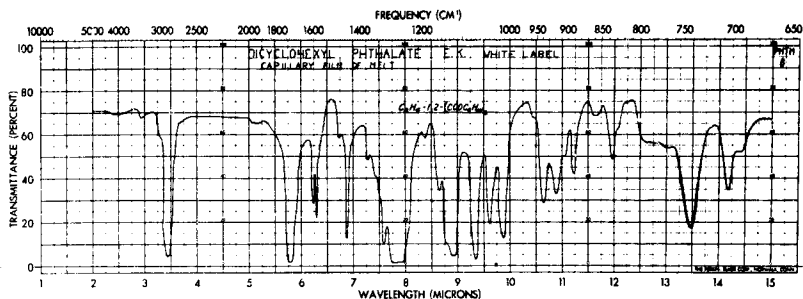


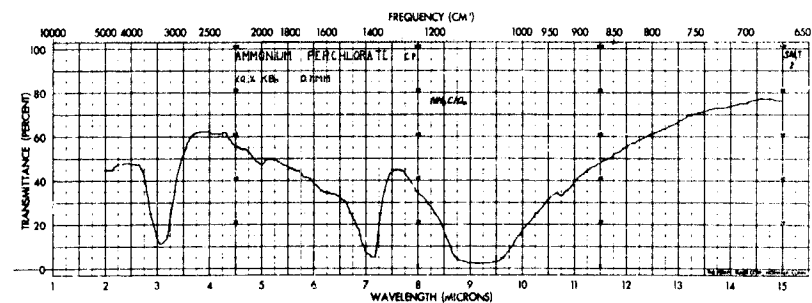
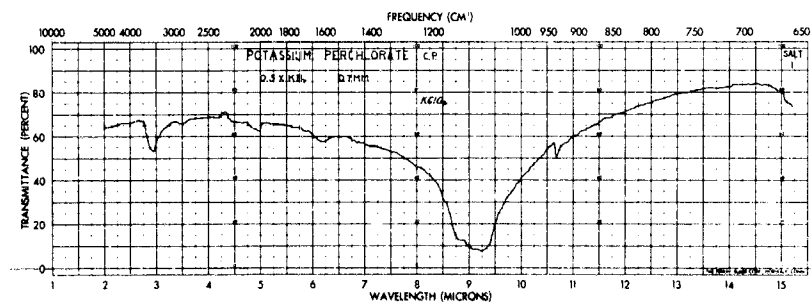
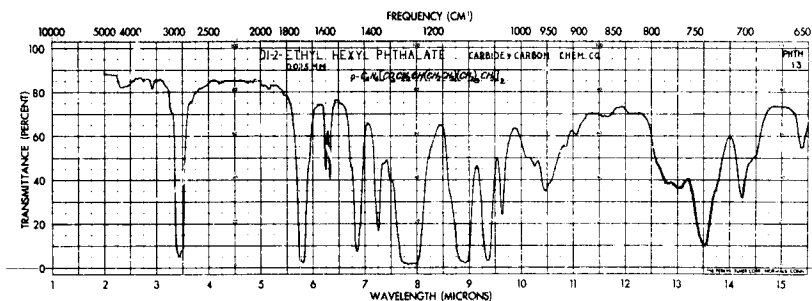
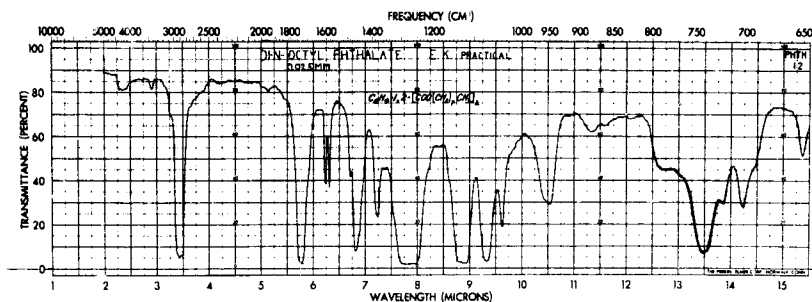


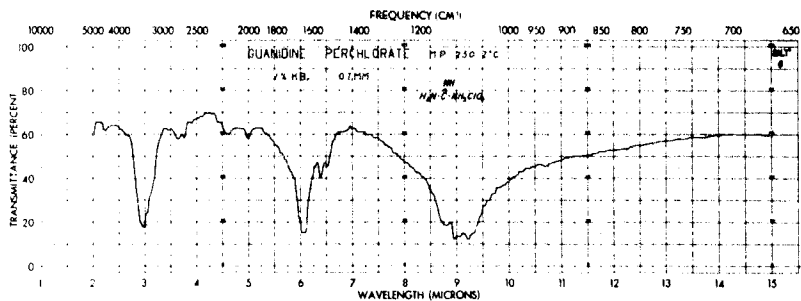
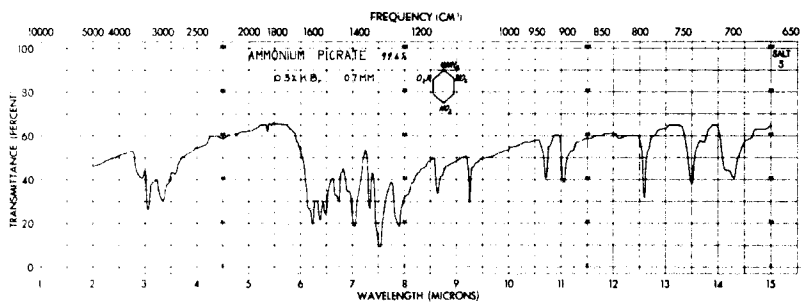
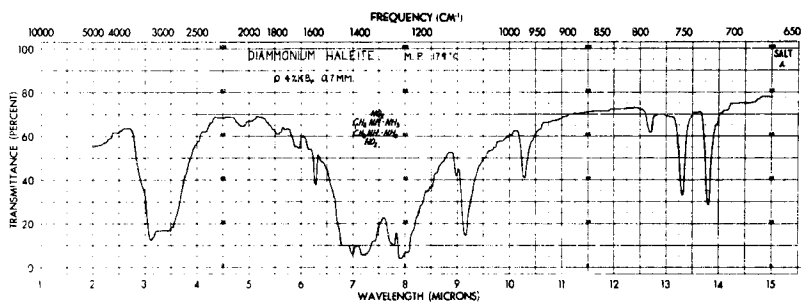
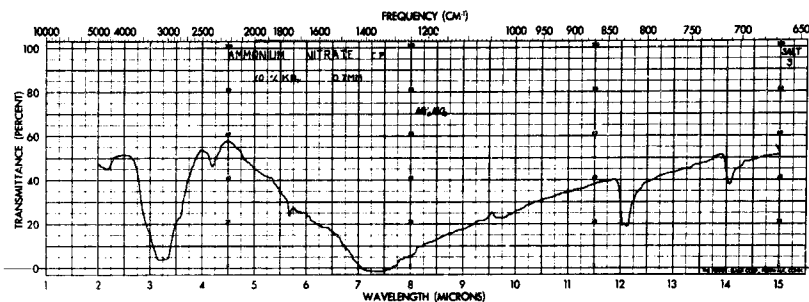


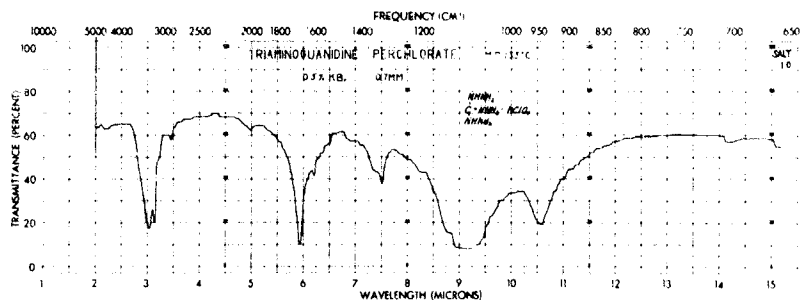
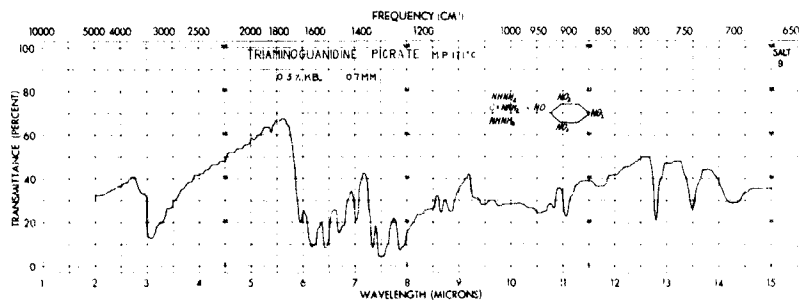
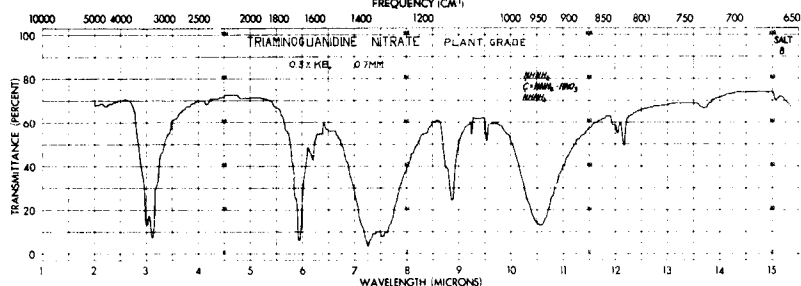
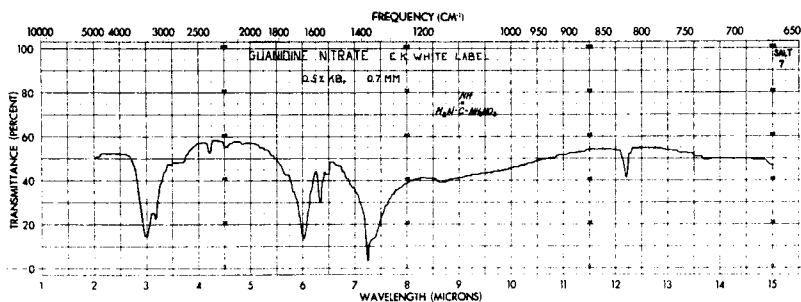


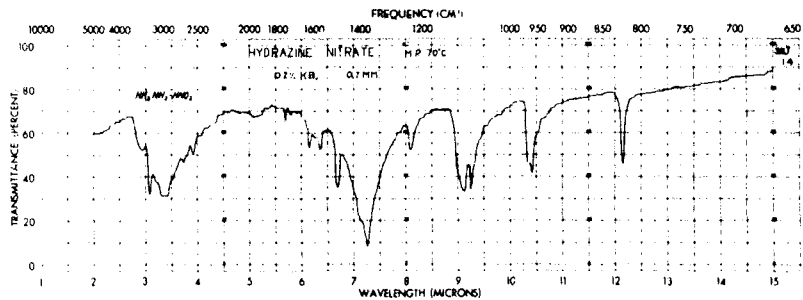
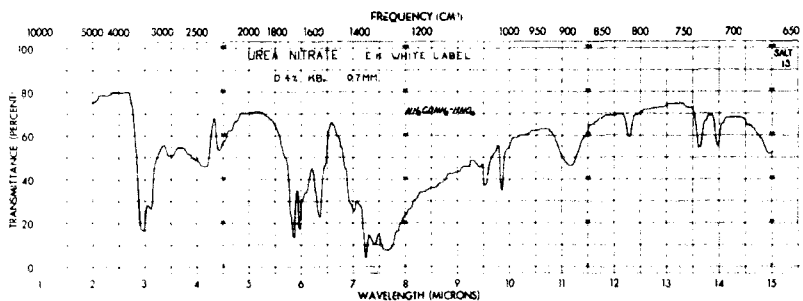
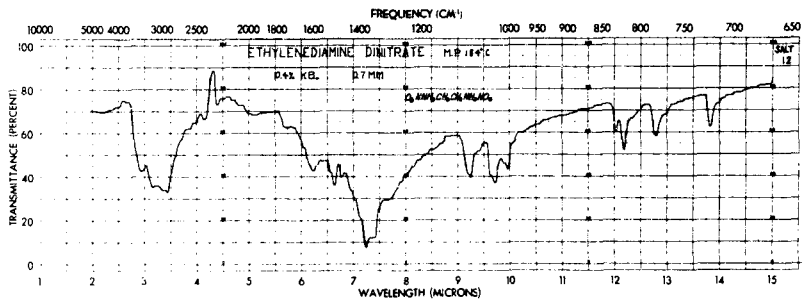
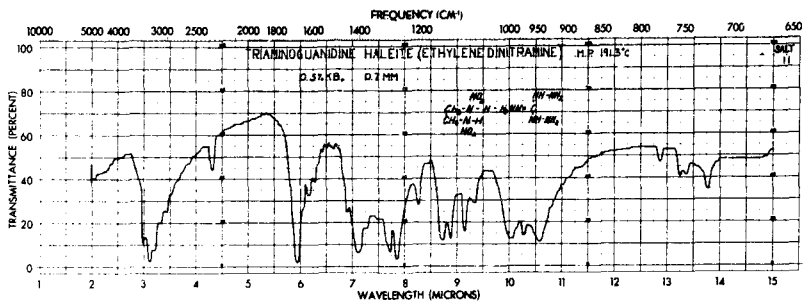


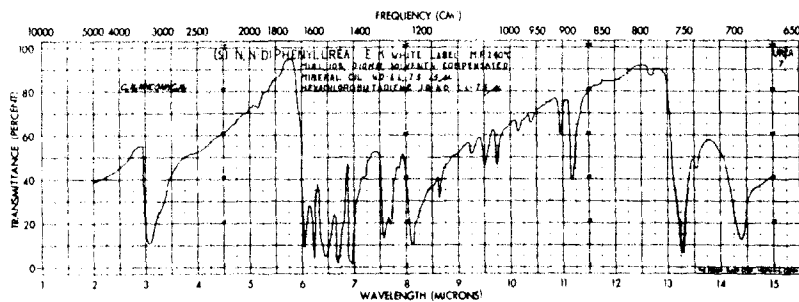
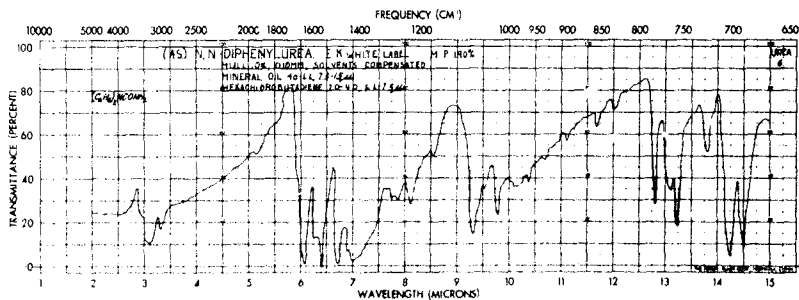
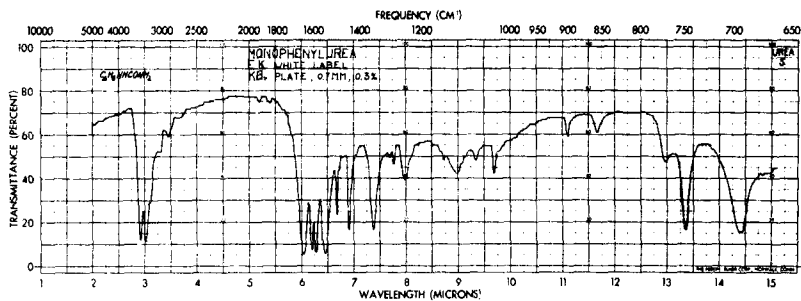
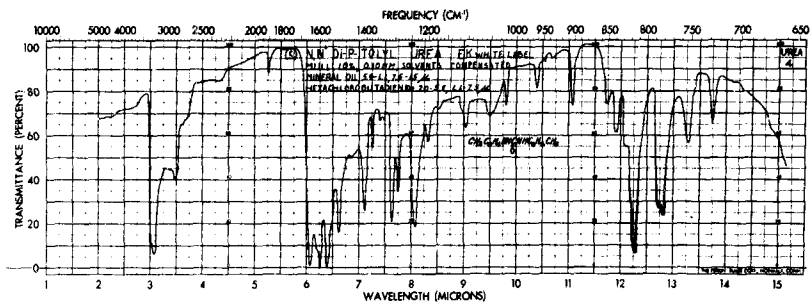


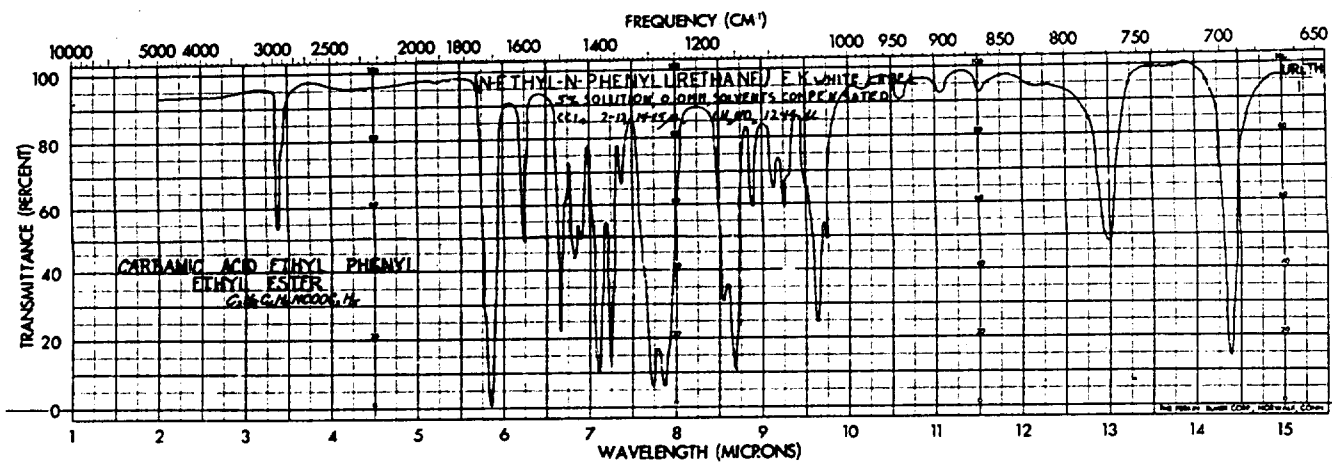












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A comprehensive compilation consisting of 176 infrared spectra of ingredients of propellants and explosives has been prepared and is presented herein. The spectra are arranged in the following groups, which are listed alphabetically, Acetates, Amines, Esters, Metal Organics, Misc., Polymers, Nitro Amines, Nitro Aromatics, Organo Nitrates, Phosphates, Phthalates, Salts, Ureas, Urethanes. Within each group the individual spectra have been arranged in such a way so that related compounds are placed together.			

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