รายการอ้างอิง

1. นเรศร์ จันทน์ขาว. เทคนิคการวิเคราะห์รังสีเอกซ์เรืองเชิงปริมาณ. เอกสารประกอบการสอน ภาควิชานิวเคลียร์เทคโนโลยี คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, 2538.
2. แสงโรจน์ ภววงษ์ศักดิ์. เครื่องวิเคราะห์การเรืองรังสีเอกซ์ด้วยต้นกำเนิดรังสีกระตุ้นแบบสี่ไอโซโทป. วิทยานิพนธ์ปริญญามหาบัณฑิตภาควิชานิวเคลียร์เทคโนโลยี บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย, 2531.
3. R.L. Martin . NBSGSC Version 4.0 ; Fundamental Parameters X-Ray Analysis for Personal Computers. Rainier Software , Enumclaw , 1988.

บรรณานุกรม

นเรศร์ จันทน์ขาว. การวิเคราะห์ธาตุด้วยวิธีเรืองรังสีเอกซ์เชิงปฏิบัติ. เอกสารประกอบการสอนนิสิตภาควิชานิวเคลียร์เทคโนโลยี คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, 2522.

แสงโรจน์ ภววงษ์ศักดิ์. เครื่องวิเคราะห์การเรืองรังสีเอกซ์ด้วยต้นกำเนิดรังสีกระตุ้นแบบสี่ไอโซโทป. วิทยานิพนธ์ปริญญามหาบัณฑิตภาควิชานิวเคลียร์เทคโนโลยี บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย, 2531.

สุนันทา ทิพย์มาลย์มาศ. การหาปริมาณความเข้มข้นของตะกั่วในอากาศโดยเทคนิคการเรืองรังสีเอกซ์. วิทยานิพนธ์ปริญญามหาบัณฑิตภาควิชานิวเคลียร์เทคโนโลยี บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย, 2532.

Glenn. F. Knoll. Radiation Detection And Measurement. 2 nd ed. Newyork : John Willey& Sons, 1989.

ภาคผนวก

ภาคผนวก ก.

ตัวอย่างผลการคำนวณจากโปรแกรม NBSGSC

สำหรับตัวอย่าง Pb/Sn Alloys

```
      calco87
0;44;37m$p$g
2J
                        CALCO87 (NBSGSC) Version 4.3

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Adapted for MS-DOS from the NBS mainframe by R. Martin, Rainier Software.
The original NBS authors: G.Y. Tao, P.A. Pella, R.M. Rousseau.
See NBS Technical Note 1213 for a full description.

Serial No. 92-0105  for D.K. Book House client, Thailand.

Date:  04-23-1998      Time:  20:28:16

Be sure CAPS LOCK is OFF.

For best output format, use a 132 column printer or 80 column printer in
compressed mode.  The system should be booted with DEVICE=ANSI.SYS in the
CONFIG.SYS file.

How do you wish to enter data:
  1-from the keyboard  2-from spreadsheet file?  1

Which system do you wish to analyze:
  1-element system  2-oxide system  3-fused disk system?  1

Input number of analytes (Max.=25):  2

Input names of elements (Max.=25), right-justified (A2); e.g., Cr or _P:

I= 1  Pb
I= 2  Sn

What mass absorption coefficient algorithm do you want to use:
  1-Leroux algorithm   2-Heinrich algorithm?  2

Do you want to save calculated alpha coefficients to a datafile (y/n)?  y

Input datafile name of alpha coefficients:  a:pbsn.coe

Sample geometry: input incidence & emergence angles (degrees from horizontal);
two numbers on one line separated by a comma:  90,90

Do you want to filter the incident radiation for any analytes (y/n)?  y

Input name of filter element, right-justified (A2); e.g., Al or _V:  Be

Input filter density-thickness (g/cm2), which is obtained by multiplying
the density (g/cm3) by the thickness (cm):  .0552

Input the characteristic line number you wish to measure,
1-KA, 2-KB, 3-LA1, 4-LB1, 5-LB2, followed by y/n for use of filter.
No space between integer and letter; e.g., 1y or 3n, (I1,A1):

I= 1    Pb    3y
I= 2    Sn    1y

Do you want to print out calculated alpha coefficients (y/n)?  y

Which X-ray tube spectral distribution do you prefer:
```

```
  1-Calculated spectrum from NBS algorithm;  2-measured spectrum?  2

Input the datafile name of X-ray tube spectrum:  am241.sou

Do you want to print out the spectral distribution (y/n)?  y

Do you want to save the spectral distribution to a datafile (y/n)?  y

 Input the datafile name of the spectral distribution:  a:pbsn.spe
```

MEASURED X-RAY TUBE SPECTRAL DISTRIBUTION

X-ray tube target: AM KV: .0
Take-off angle (degree): .0 Be window thickness (mm): .000

Lambda(A)	I*.02A	Lambda(A)	I*.02A	Lambda(A)	I*.02A	Lambda(A)	I*.02A	Lambda(A)	I*.02A
1.0400	.8600E-02	.8910	.1320E+00	.6960	.1925E+00	.5950	.4850E-01	.4698	.2400E-01
.2080	.3590E+00								

The continuum integral is .7646E+00

KA	KB	LA1	LB1	LB2	LB3	LB4	LG1	LG2	LG3
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00

Basic alpha coefficients for use in COLA equation

(elemental system)

Target: AM .0 KV Filter: yes
Geometry: 90,90 degrees

Analyte: Pb (82)

Matrix Constituents

		82	50
		Pb	Sn
	A1	.000	-.339
	A2	.000	-.023
	A3	.000	2.206
AIJK	82 Pb	.000	
	50 Sn	.000	

Basic alpha coefficients for use in COLA equation

(elemental system)

Target: AM .0 KV Filter: yes
Geometry: 90,90 degrees

Analyte: Sn (50)

Matrix Constituents

		82	50
		Pb	Sn
	A1	1.813	.000
	A2	.000	.000
	A3	-.994	.000
AIJK	82 Pb	.000	
	50 Sn	.000	

Date: 04-23-1998

Start time: 20:28:16 End time: 20:32:09

Stop - Program terminated.

```
stdmake
0;44;37m$p$g
2J

                              STDMAKE (NBSGSC)

Program to enter standards data onto disk file.

What type of standards are available?
1-pure element standards  2-multielement standards:  2

Input number of standards (Max.=20):   5

Do the unknowns contain known concentrations of unanalyzed elements?  (y/n)  n

Input number of analytes (Max.=25):   2

Input names of analytes, 8 characters max., left-justified:

 I= 1    Pb
 I= 2    Sn

Input I.D. of standards, 8 characters max., left-justified:

 I= 1    t0
 I= 2    t40
 I= 3    t49
 I= 4    t60
 I= 5    t100

Input concentrations (weight fraction) of constituents in the standards;
listed in analyte order on one line; separate numbers with commas;
max. line length is 80 characters:

 I= 1    t0        1,0
 I= 2    t40       .6,.4
 I= 3    t49       .51,.49
 I= 4    t60       .4,.6
 I= 5    t100      0,1

Input net intensities for analytes in standards; listed in analyte order
on one line; separate numbers with commas; max. line length 80 characters:

 I= 1    t0        31819,0
 I= 2    t40       22263,157234
 I= 3    t49       19911,209801
 I= 4    t60       17549,271154
 I= 5    t100      0,660780

Input datafile name for standards:   a:1pbsn.std

Finished.
```

```
      unkmake
0;44;37m$p$g
2J

                              UNKMAKE (NBSGSC)

Program to enter unknown data onto disk file.

Do you want to input known concentrations of unanalyzed elements? (y/n)   n

Input number of analytes (Max.=25), and number of unknowns to be
analyzed (Max.=20); two numbers on one line separated by a comma:  2,5

Input names of analytes, 8 characters max., left-justified:

 I= 1    Pb
 I= 2    Sn

Input I.D. of unknowns to be analyzed, 8 characters max., left-justified:

 I= 1    t63
 I= 2    t63a
 I= 3    k50
 I= 4    k40
 I= 5    k100

Input net intensities for analytes in unknowns; listed in element order on
one line; separate numbers with commas; max. line length is 80 characters:

 I= 1    t63       16429,290611
 I= 2    t63a      17074,282673
 I= 3    k50       20012,211066
 I= 4    k40       23164,158194
 I= 5    k100      0,644290

Input datafile name for unknowns:   a:1pbsn.unk

Finished.
```

```
      comp87
0;44;37m$p$g
2J
                        COMP87 (NBSGSC) Version 4.3

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The original NBS authors: G.Y. Tao, P.A. Pella, R.M. Rousseau.
See NBS Technical Note 1213 for a full description.

Serial No. 92-0105  for D.K. Book House client, Thailand.

Date:  04-23-1998      Time:  20:46:26

Be sure CAPS LOCK is OFF.

For best output format, use a 132 column printer or 80 column printer in
compressed mode.  The system should be booted with DEVICE=ANSI.SYS in the
CONFIG.SYS file.

What type of unknowns do you wish to analyze:
  1-element system   2-oxide system   3-fused disk system?  1

Do you want to input standards and unknowns data by:

1-UNKMAKE and STDMAKE datafiles
2-UNKLOTUS and STDLOTUS spreadsheet files
3-keyboard?     1

Input datafile name for unknowns:   a:1pbsn.unk

Do you want to input alpha coefficients by: 1-datafile  2-keyboard?   1

Input datafile name of alpha coefficients:   a:pbsn.coe

Input datafile name for standards:   a:1pbsn.std

Do you want to correct intensities for dead time (y/n)?  n

Do you want to print out calculated relative intensities of standards &
calculated pure intensities from standards?  (y/n)  y

Calculated relative intensities of standards:

                          Pb        Sn
  Std.No.= t0          1.00000    .00000
  Std.No.= t40          .69542    .19158
  Std.No.= t49          .61353    .25458
  Std.No.= t60          .50495    .34777
  Std.No.= t100         .00000   1.00000

Calculated pure intensities from standards:

                          Pb        Sn
  Std.No.= t0          31819.        0.
  Std.No.= t40         32014.   820728.
  Std.No.= t49         32453.   824101.
  Std.No.= t60         34754.   779692.
  Std.No.= t100            0.   660780.

Average values         32760.   771325.
```

```
What type of LSF curves do you want to use for calibration:
   (1) Y=A0+A1*X       (2) Y=A0+A1*X+A2*X*X
   (3) Y=A1*X          (4) Y=A1*X+A2*X*X    ? 4

Do you want to print out LSF coefficients? (y/n)  y

              Tabulation of calculated LSF coefficients
                 (X=meas.int.  ;  Y=calc.rel.int.)

Pb         A0=  .00000E+00  A1=  .28189E-04  A2=  .10629E-09
Sn         A0=  .00000E+00  A1=  .11066E-05  A2=  .61570E-12

Enter graphics device driver to load to display calibration curve:

        0 - Continue without further plotting
        1 - Screen driver file SCREEN.DRV
        2 - Plotter driver file PLOTTER.DRV
        3 - Printer driver file PRINTER.DRV:   0

-----RESULTS OF LAST ITERATION-----


Smp.No.=t63     R=Pb       .4918  Sn       .3736
   No. iter.= 5 C=Pb     38.367%  Sn     63.349%
                Total= 101.72%


Smp.No.=t63a    R=Pb       .5123  Sn       .3620
   No. iter.= 5 C=Pb     40.115%  Sn     62.533%
                Total= 102.65%


Smp.No.=k50     R=Pb       .6067  Sn       .2610
   No. iter.= 5 C=Pb     50.244%  Sn     49.878%
                Total= 100.12%


Smp.No.=k40     R=Pb       .7100  Sn       .1905
   No. iter.= 5 C=Pb     61.212%  Sn     40.187%
                Total= 101.40%


Smp.No.=k100    R=Pb       .0000  Sn       .9686
   No. iter.= 1 C=Pb       .000%  Sn     96.857%
                Total=  96.86%


                                        TABULATION OF RESULTS (%)

 Smp.No.    Total     Pb       Sn

 t63        101.72  38.367   63.349

 t63a       102.65  40.115   62.533

 k50        100.12  50.244   49.878

 k40        101.40  61.212   40.187

 k100        96.86    .000   96.857
```

Do you wish to save the TABULATION OF [illegible]

Input the filename for the results: a:lpbsn.out

Do you wish to compare these results with other previously known values for these specimens (y/n)? n

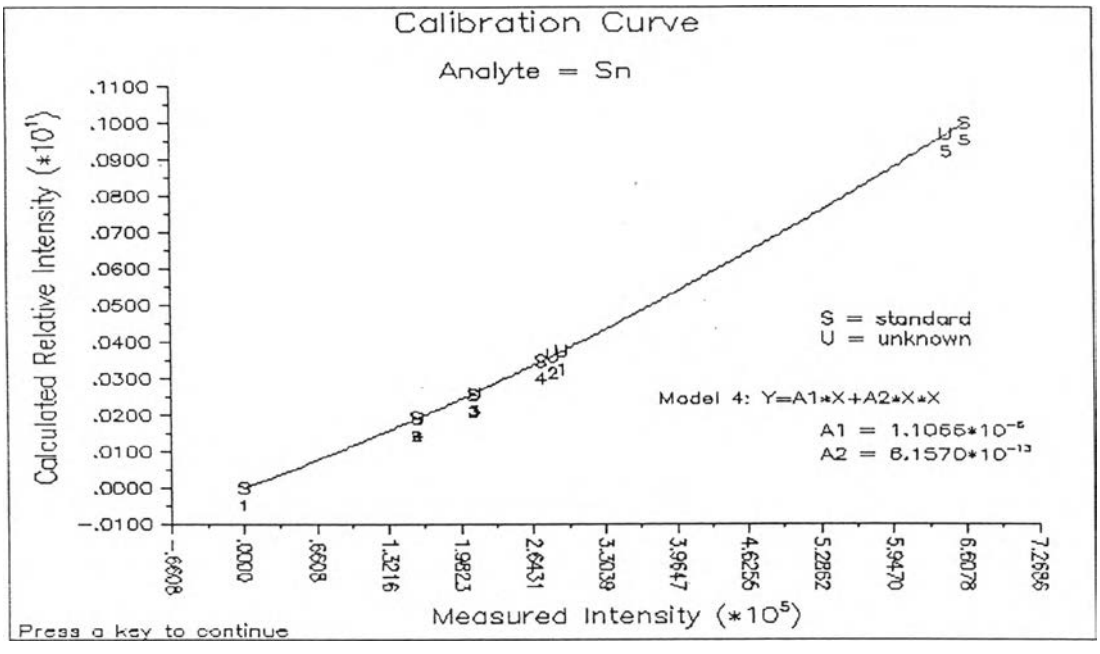
Do you want to try another type of calibration curve (y/n)? n

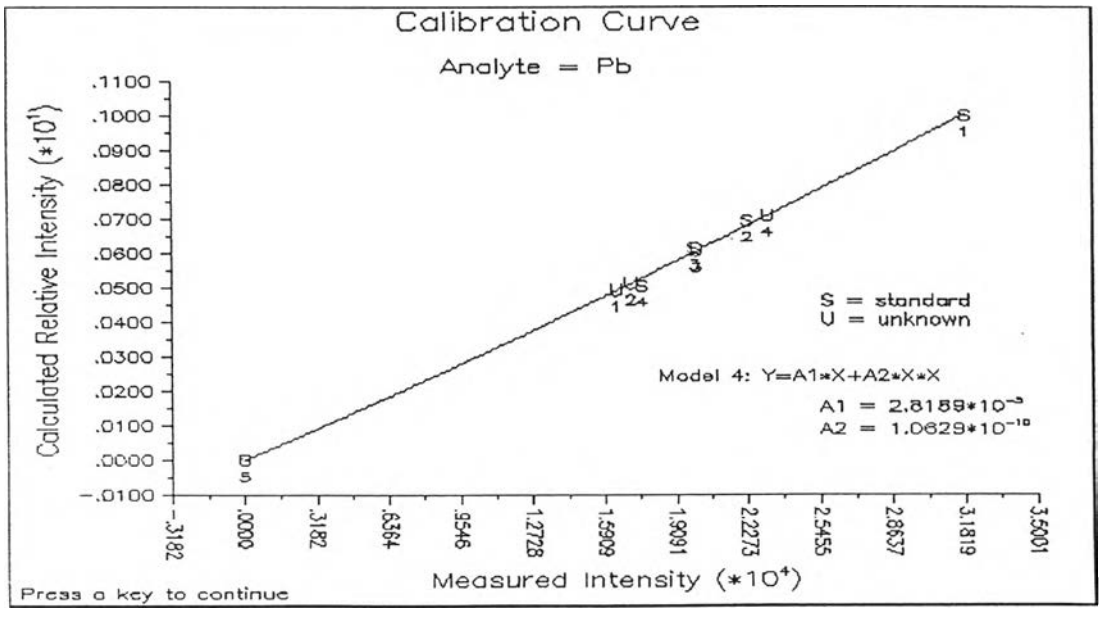
Date: 04-23-1998

Start time: 20:49:53 End time: 20:53:49

Stop - Program terminated.

กราฟปรับเทียบ (Pb/Sn Alloys)





ภาคผนวก ข.

ตัวอย่างผลการคำนวณจากโปรแกรม NBSGSC

สำหรับตัวอย่าง **Stainless Steel**

```
      calco87
0;44;37m$p$g
2J
                        CALCO87 (NBSGSC) Version 4.3

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Adapted for MS-DOS from the NBS mainframe by R. Martin, Rainier Software.
The original NBS authors: G.Y. Tao, P.A. Pella, R.M. Rousseau.
See NBS Technical Note 1213 for a full description.

Serial No. 92-0105  for D.K. Book House client, Thailand.

Date:  04-27-1998      Time:  20:58:56

Be sure CAPS LOCK is OFF.

For best output format, use a 132 column printer or 80 column printer in
compressed mode.  The system should be booted with DEVICE=ANSI.SYS in the
CONFIG.SYS file.

How do you wish to enter data:
  1-from the keyboard  2-from spreadsheet file?  1

Which system do you wish to analyze:
  1-element system  2-oxide system  3-fused disk system?  1

Input number of analytes (Max.=25):  9

Input names of elements (Max.=25), right-justified (A2); e.g., Cr or _P:

I= 1   C
I= 2  Si
I= 3  Mn
I= 4   P
I= 5   S
I= 6  Cr
I= 7  Fe
I= 8  Ni
I= 9  As

What mass absorption coefficient algorithm do you want to use:
  1-Leroux algorithm   2-Heinrich algorithm?  2

Do you want to save calculated alpha coefficients to a datafile (y/n)?  y

Input datafile name of alpha coefficients:  a:amst.coe

Sample geometry: input incidence & emergence angles (degrees from horizontal);
two numbers on one line separated by a comma:  90,90

Do you want to filter the incident radiation for any analytes (y/n)?  y

Input name of filter element, right-justified (A2); e.g., Al or _V:  Be

Input filter density-thickness (g/cm2), which is obtained by multiplying
the density (g/cm3) by the thickness (cm):  .0552

Input the characteristic line number you wish to measure,
1-KA, 2-KB, 3-LA1, 4-LB1, 5-LB2, followed by y/n for use of filter.
No space between integer and letter; e.g., 1y or 3n, (I1,A1):
```

```
I= 1     C    1n
I= 2    Si    1n
I= 3    Mn    1n
I= 4     P    1n
I= 5     S    1n
I= 6    Cr    1y
I= 7    Fe    1y
I= 8    Ni    1y
I= 9    As    1n

Do you want to print out calculated alpha coefficients (y/n)?  y

Which X-ray tube spectral distribution do you prefer:
  1-Calculated spectrum from NBS algorithm;  2-measured spectrum?  2

Input the datafile name of X-ray tube spectrum:  am241.sou

Do you want to print out the spectral distribution (y/n)?  y

Do you want to save the spectral distribution to a datafile (y/n)?  y

 Input the datafile name of the spectral distribution:  a:amst.spe
```

MEASURED X-RAY TUBE SPECTRAL DISTRIBUTION

X-ray tube target: AM KV: .0
Take-off angle (degree): .0 Be window thickness (mm): .000

Lambda(A)	I*.02A	Lambda(A)	I*.02A	Lambda(A)	I*.02A	Lambda(A)	I*.02A	Lambda(A)	I*.02A
1.0400	.8600E-02	.8910	.1320E+00	.6960	.1925E+00	.5950	.4850E-01	.4698	.2400E-01
.2080	.3590E+00								

The continuum integral is .7646E+00

KA	KB	LA1	LB1	LB2	LB3	LB4	LG1	LG2	LG3
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00

Basic alpha coefficients for use in COLA equation

(elemental system)

Target: AM .0 KV Filter: no
Geometry: 90,90 degrees

Analyte: C (6)

Matrix Constituents

			6	14	25	15	16	24	26	28	33
			C	Si	Mn	P	S	Cr	Fe	Ni	As
	A1		.000	-2.158	-10.720	-2.122	-2.116	-9.183	-12.398	-16.438	-28.074
	A2		.000	1.717	9.962	1.796	1.917	8.403	11.666	15.709	27.472
	A3		.000	-.958	-.951	-.946	-.935	-.943	-.957	-.968	-.982
AIJK	6	C	.000								
	14	Si	.000								
	25	Mn	.000	.086							
	15	P	.000	.598	.254						
	16	S	.000	.807	.442	.801					
	24	Cr	.000	.168	-.001	.335	.518				
	26	Fe	.000	.009	-.001	.175	.364	.667			
	28	Ni	.000	-.183	.678	-.031	.151	.691	.664		
	33	As	.000	-.410	.703	-.291	-.136	.694	.707	.667	

Basic alpha coefficients for use in COLA equation

(elemental system)

Target: AM .0 KV Filter: no
Geometry: 90,90 degrees

Analyte: Si (14)

Matrix Constituents

		6	14	25	15	16	24	26	28	33
		C	Si	Mn	P	S	Cr	Fe	Ni	Asr
A1		.079	.000	4.628	.199	.473	3.995	5.317	6.856	11.846
A2		.000	.000	-2.490	-.375	-.495	-2.195	-2.796	-3.446	-5.155
A3		2.019	.000	-.309	4.471	3.082	-.192	-.403	-.547	-.743
AIJK	6 C	.000								
	14 Si	.000								
	25 Mn	.268	.000							
	15 P	-.006	.000	2.396						
	16 S	.014	.000	2.545	.338					
	24 Cr	.257	.000	.001	2.147	2.270				
	26 Fe	.274	.000	.001	2.622	2.798	3.702			
	28 Ni	.265	.000	4.576	2.998	3.226	4.510	4.641		
	33 As	.216	.000	6.025	3.445	3.765	5.881	6.163	6.412	

Basic alpha coefficients for use in COLA equation

(elemental system)

Target: AM .0 KV Filter: no
Geometry: 90,90 degrees

Analyte: Mn (25)

Matrix Constituents

		6 C	14 Si	25 Mn	15 P	16 S	24 Cr	26 Fe	28 Ni	33 As
A1		-.900	.259	.000	.524	.818	-.114	.122	-.053	.406
A2		-.002	-.027	.000	-.032	-.038	.000	.000	-.450	-.552
A3		9.325	-.245	.000	-.372	-.472	-1.044	-.591	.523	-.081
AIJK	6 C	.000								
	14 Si	.007								
	25 Mn	.000	.000							
	15 P	.008	.000	.000						
	16 S	.009	.000	.000	.000					
	24 Cr	.001	.025	.000	.029	.033				
	26 Fe	.001	.026	.000	.030	.034	.000			
	28 Ni	.163	-.343	.000	-.439	-.540	.431	.443		
	33 As	.170	-.474	.000	-.602	-.737	.513	.534	.789	

Basic alpha coefficients for use in COLA equation

(elemental system)

Target: AM .0 KV Filter: no
Geometry: 90,90 degrees

Analyte: P (15)

Matrix Constituents

		6	14	25	15	16	24	26	28	33
		C	Si	Mn	P	S	Cr	Fe	Ni	As
	A1	-.170	8.717	3.364	.000	.162	2.880	3.892	5.072	8.926
	A2	.000	-.003	-1.936	.000	-.401	-1.715	-2.164	-2.649	-3.935
	A3	.357	-.899	-.195	.000	3.942	-.065	-.301	-.464	-.691
AIJK	6 C	.000								
	14 Si	.000								
	25 Mn	.275	-3.649							
	15 P	.000	.000	.000						
	16 S	.019	-.692	1.892	.000					
	24 Cr	.257	-3.234	.001	.000	1.689				
	26 Fe	.289	-4.038	.001	.000	2.081	2.799			
	28 Ni	.301	-4.784	3.461	.000	2.410	3.402	3.521		
	33 As	.296	-5.921	4.568	.000	2.864	4.452	4.681	4.887	

Basic alpha coefficients for use in COLA equation

(elemental system)

Target: AM .0 KV Filter: no
Geometry: 90,90 degrees

Analyte: S (16)

Matrix Constituents

			6	14	25	15	16	24	26	28	33
			C	Si	Mn	P	S	Cr	Fe	Ni	As
	A1		-.352	6.655	2.444	8.213	.000	2.068	2.853	3.769	6.783
	A2		.000	-.004	-1.537	-.005	.000	-1.370	-1.710	-2.076	-3.051
	A3		5.604	-.862	-.080	-.888	.000	.065	-.198	-.379	-.635
AIJK	6	C	.000								
	14	Si	.000								
	25	Mn	.264	-2.793							
	15	P	.000	.000	-3.257						
	16	S	.000	.000	.000	.000					
	24	Cr	.245	-2.481	.001	-2.884	.000				
	26	Fe	.281	-3.083	.001	-3.609	.000	2.167			
	28	Ni	.302	-3.642	2.673	-4.290	.000	2.621	2.726		
	33	As	.325	-4.498	3.522	-5.369	.000	3.426	3.615	3.788	

Target: AM .0 KV Filter: yes
Geometry: 90,90 degrees

Analyte: Cr (24)

Matrix Constituents

		6	14	25	15	16	24	26	28	33
		C	Si	Mn	P	S	Cr	Fe	Ni	As
	A1	-.879	.511	.129	.829	1.180	.000	-.084	.086	.638
	A2	-.002	-.024	.000	-.029	-.035	.000	-.449	-.510	-.636
	A3	6.970	-.356	-1.116	-.470	-.553	.000	.855	.389	-.147
AIJK	6 C	.000								
	14 Si	.006								
	25 Mn	.001	.023							
	15 P	.007	.000	.026						
	16 S	.008	.000	.030	.000					
	24 Cr	.000	.000	.000	.000	.000				
	26 Fe	.159	-.374	-.316	-.473	-.575	.000			
	28 Ni	.174	-.466	.506	-.587	-.713	.000	.655		
	33 As	.183	-.621	.609	-.779	-.945	.000	.827	.890	

Basic alpha coefficients for use in COLA equation

(elemental system)

Target: AM .0 KV Filter: yes
Geometry: 90,90 degrees

Analyte: Fe (26)

Matrix Constituents

		6	14	25	15	16	24	26	28	33
		C	Si	Mn	P	S	Cr	Fe	Ni	As
	A1	-.917	.053	-.108	.276	.523	3.429	.000	-.168	.218
	A2	-.002	-.028	.000	-.034	-.041	-.117	.000	-.401	-.485
	A3	9.345	-.103	-.900	-.264	-.382	-.785	.000	.672	-.011
AIJK	6 C	.000								
	14 Si	.008								
	25 Mn	.001	.027							
	15 P	.010	.000	.032						
	16 S	.011	.000	.037	.000					
	24 Cr	.018	.003	.064	.002	.002				
	26 Fe	.000	.000	.000	.000	.000	.000			
	28 Ni	.152	-.245	.381	-.322	-.403	-1.090	.000		
	33 As	.159	-.358	.457	-.461	-.570	-1.549	.000	.705	

Basic alpha coefficients for use in COLA equation

(elemental system)

Target: AM .0 KV Filter: yes
Geometry: 90,90 degrees

Analyte: Ni (28)

Matrix Constituents

		6	14	25	15	16	24	26	28	33
		C	Si	Mn	P	S	Cr	Fe	Ni	As
A1		-.942	-.253	2.509	-.095	.081	2.163	2.874	.000	-.061
A2		-.002	-.030	-.140	-.036	-.043	-.126	-.154	.000	-.385
A3		18.373	.187	-.741	-.014	-.171	-.712	-.765	.000	.148
AIJK	6 C	.000								
	14 Si	.010								
	25 Mn	.027	.006							
	15 P	.012	.000	.004						
	16 S	.014	.000	.003	.000					
	24 Cr	.026	.005	.000	.004	.003				
	26 Fe	.028	.006	.000	.005	.004	.000			
	28 Ni	.000	.000	.000	.000	.000	.000	.000		
	33 As	.142	-.188	-1.055	-.254	-.324	-.971	-1.137	.000	

Basic alpha coefficients for use in COLA equation

(elemental system)

Target: AM .0 KV Filter: no
Geometry: 90,90 degrees

Analyte: As (33)

Matrix Constituents

		6	14	25	15	16	24	26	28	33
		C	Si	Mn	P	S	Cr	Fe	Ni	As
	A1	-.974	-.654	.656	-.580	-.497	.491	.831	1.209	.000
	A2	-.002	-.030	-.141	-.036	-.043	-.127	-.156	-.188	.000
	A3	34.118	1.019	-.550	.689	.426	-.501	-.591	-.660	.000
AIJK	6 C	.000								
	14 Si	.011								
	25 Mn	.040	.012							
	15 P	.013	.000	.010						
	16 S	.016	.001	.007	.000					
	24 Cr	.038	.011	.000	.008	.006				
	26 Fe	.042	.013	.000	.011	.008	.000			
	28 Ni	.046	.016	.000	.013	.011	.001	.000		
	33 As	.000	.000	.000	.000	.000	.000	.000	.000	

Date: 04-27-1998

Start time: 20:58:56 End time: 21:03:08

Stop - Program terminated.

```
stdmake
0;44;37m$p$g
2J

                              STDMAKE (NBSGSC)

Program to enter standards data onto disk file.

What type of standards are available?
1-pure element standards  2-multielement standards:  2

Input number of standards (Max.=20):   6

Do the unknowns contain known concentrations of unanalyzed elements?  (y/n)  y

Input number of all constituents (Max.=26), number of analytes (Max.=25);
two numbers on one line separated by a comma:   9,3

Input names of all constituents, 8 characters max., left-justified:

 I= 1    C
 I= 2    Si
 I= 3    Mn
 I= 4    P
 I= 5    S
 I= 6    Cr
 I= 7    Fe
 I= 8    Ni
 I= 9    As

Input names of analytes, 8 characters max., left-justified:

 I= 1    Cr
 I= 2    Fe
 I= 3    Ni

Input I.D. of standards, 8 characters max., left-justified:

 I= 1    461
 I= 2    462
 I= 3    463
 I= 4    464
 I= 5    467
 I= 6    468

Input concentrations (weight fraction) of constituents in the standards;
listed in analyte order on one line; separate numbers with commas;
max. line length is 80 characters:

 I= 1    461       .00082,.0044,.0064,.00013,.00017,.1520,.77437,.0616,.00011
 I= 2    462       .00092,.0046,.0074,.00010,.00018,.1235,.73773,.1255,.00007
 I= 3    463       .00088,.0051,.0077,.00015,.00017,.1830,.7065,.0965,0
 I= 4    464       .00000,.0064,.0077,.00016,.00010,.2575,.52011,.2070,.00003
 I= 5    467       .00069,.0045,.0068,.00015,.00019,.1805,.71767,.0895,0
 I= 6    468       .00152,.0114,.0147,.00016,.00026,.1870,.69666,.0883,0

Input net intensities for analytes in standards and enter 0 for each
unanalyzed element; listed in analyte order on one line; separate numbers with
commas; max. line length is 80 characters:
```

```
I= 1    461        0,0,0,0,0,8008.5,58324,3527,0
I= 2    462        0,0,000,0,6130,59160,5,7329,0
I= 3    463        0,0,0,0,0,8893.5,48484.5,5990,0
I= 4    464        0,0,0,0,0,10728,33818.5,13512,0
I= 5    467        0,0,0,0,0,7928,49497.5,4083,0
I= 6    468        0,0,0,0,0,8998,50893.5,3803,0

Input datafile name for standards:   a:1steel.std

Finished.
```

```
      unkmake
0;44;37m$p$g
2J

                              UNKMAKE (NBSGSC)

Program to enter unknown data onto disk file.

Do you want to input known concentrations of unanalyzed elements? (y/n)   y

Input number of all constituents (Max.=26), number of analytes (Max.=25), and
number of unknowns to be analyzed (Max.=20); three numbers on one line
separated by commas:  9,3,3

Input names of all constituents, 8 characters max., left-justified:

 I= 1    C
 I= 2    Si
 I= 3    Mn
 I= 4    P
 I= 5    S
 I= 6    Cr
 I= 7    Fe
 I= 8    Ni
 I= 9    As

Input names of analytes, 8 characters max., left-justified:

 I= 1    Cr
 I= 2    Fe
 I= 3    Ni

Input I.D. of unknowns to be analyzed, 8 characters max., left-justified:

 I= 1    d189
 I= 2    sc17
 I= 3    lm1811

Input net intensities for analytes in unknowns and enter concentrations
(weight fraction) for unanalyzed elements; listed in element order on one line;
separate numbers with commas; max. line length is 80 characters:

 I= 1    d189      .00045,.00430,.01650,.00027,.00005,8761.5,48564.5,3851,0
 I= 2    sc17      .00070,.00500,.00380,.00033,.00007,8198,56051,5,0,0
 I= 3    lm1811    .00019,.00540,.01720,.00018,.00001,7807.5,49721,6578,0

Input datafile name for unknowns:   a:1steel.unk

Finished.
```

```
      comp87
0;44;37m$p$g
2J
                    COMP87 (NBSGSC) Version 4.3

This MS-DOS implementation (C) Copyright, Rainier Software, 1991.
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Adapted for MS-DOS from the NBS mainframe by R. Martin, Rainier Software.
The original NBS authors: G.Y. Tao, P.A. Pella, R.M. Rousseau.
See NBS Technical Note 1213 for a full description.

Serial No. 92-0105  for D.K. Book House client, Thailand.

Date:  05-13-1998      Time:  20:14:45

Be sure CAPS LOCK is OFF.

For best output format, use a 132 column printer or 80 column printer in
compressed mode.  The system should be booted with DEVICE=ANSI.SYS in the
CONFIG.SYS file.

What type of unknowns do you wish to analyze:
  1-element system   2-oxide system   3-fused disk system?  1

Do you want to input standards and unknowns data by:

1-UNKMAKE and STDMAKE datafiles
2-UNKLOTUS and STDLOTUS spreadsheet files
3-keyboard?     1

Input datafile name for unknowns:   a:1steel.unk

Do you want to input alpha coefficients by: 1-datafile  2-keyboard?   1

Input datafile name of alpha coefficients:   a:amst.coe

Input datafile name for standards:   a:1steel.std

Do you want to correct intensities for dead time (y/n)?  n

Do you want to print out calculated relative intensities of standards &
calculated pure intensities from standards?  (y/n)  y

Calculated relative intensities of standards:

                        Cr        Fe        Ni
 Std.No.= 461          .22192    .52119    .01795
 Std.No.= 462          .17822    .53980    .03828
 Std.No.= 463          .25009    .45022    .02912
 Std.No.= 464          .30940    .29974    .06989
 Std.No.= 467          .24877    .45858    .02682
 Std.No.= 468          .25399    .43965    .02668

Calculated pure intensities from standards:

                        Cr        Fe        Ni
 Std.No.= 461          36087.    111906.   196471.
 Std.No.= 462          34395.    109596.   191439.
 Std.No.= 463          35562.    107690.   205717.
 Std.No.= 464          34673.    112826.   193345.
 Std.No.= 467          31869.    107937.   152253.
 Std.No.= 468          35427.    115759.   142537.
```

```
Average values          34669.    110952.    180294.

What type of LSF curves do you want to use for calibration:
   (1) Y=A0+A1*X       (2) Y=A0+A1*X+A2*X*X
   (3) Y=A1*X          (4) Y=A1*X+A2*X*X    ? 2

Do you want to print out LSF coefficients? (y/n)  y

              Tabulation of calculated LSF coefficients
                 (X=meas.int.  ;  Y=calc.rel.int.)

Cr        A0=  .24949E-01  A1=  .24219E-04  A2=  .19361E-09
Fe        A0= -.66772E-01  A1=  .11842E-04  A2= -.28820E-10
Ni        A0=  .12010E-01  A1=  .24588E-05  A2=  .13505E-09

Enter graphics device driver to load to display calibration curve:

        0 - Continue without further plotting
        1 - Screen driver file SCREEN.DRV
        2 - Plotter driver file PLOTTER.DRV
        3 - Printer driver file PRINTER.DRV:   0

-----RESULTS OF LAST ITERATION-----


Smp.No.=d189    R=Cr       .2219  Fe       .5212  Ni       .0180
   No. iter.= 9 C=C        .045%  Si       .430%  Mn      1.650%  P        .027%  S        .005%  Cr     18.634%  Fe
                Ni       7.804%  As       .000%
               Total=   98.53%


Smp.No.=sc17    R=Cr       .1782  Fe       .5398  Ni       .0383
   No. iter.=10 C=C        .070%  Si       .500%  Mn       .380%  P        .033%  S        .007%  Cr     16.357%  Fe
                Ni       4.149%  As       .000%
               Total=   99.13%


Smp.No.=lm1811  R=Cr       .2501  Fe       .4502  Ni       .0291
   No. iter.= 8 C=C        .019%  Si       .540%  Mn      1.720%  P        .018%  S        .001%  Cr     16.778%  Fe
                Ni      11.030%  As       .000%
               Total=   98.33%


                                        TABULATION OF RESULTS (%)

 Smp.No.   Total    C       Si      Mn      P       S       Cr      Fe      Ni      As

 d189       98.53   .045    .430   1.650    .027    .005   18.634  69.948   7.804   .000

 sc17       99.13   .070    .500    .380    .033    .007   16.357  77.626   4.149   .000

 lm1811     98.33   .019    .540   1.720    .018    .001   16.778  68.224  11.030   .000


 Do you wish to save the TABULATION OF RESULTS to disk (y/n)?  y

 Input the filename for the results:  a:1steel.out


 Do you wish to compare these results with other previously known
```

values for these specimens (y/n)? n

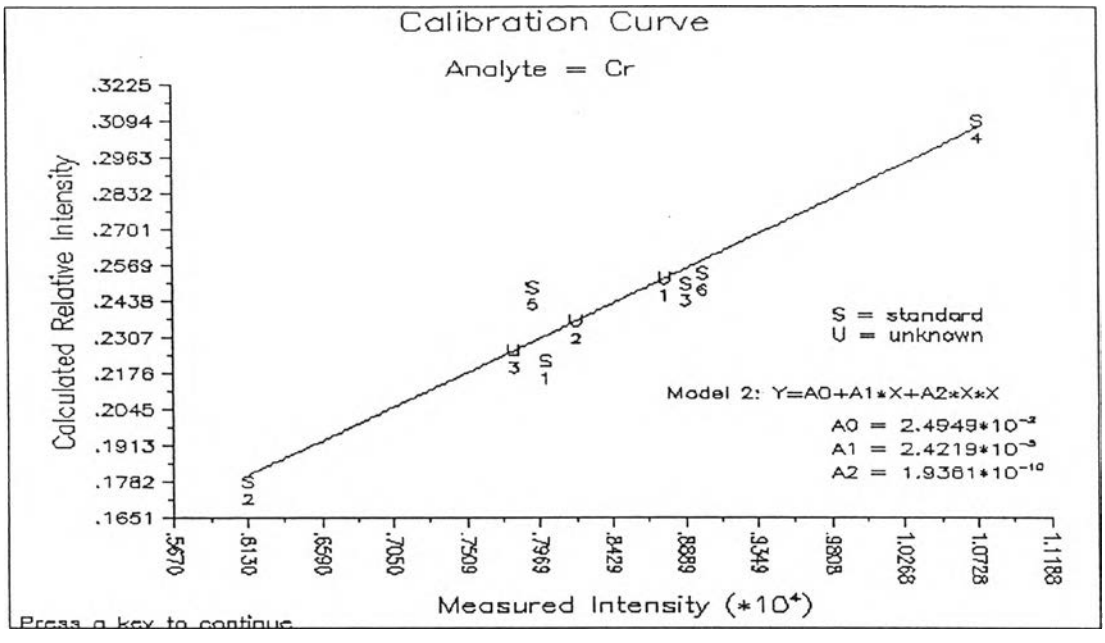
Do you want to try another type of calibration curve (y/n)? n

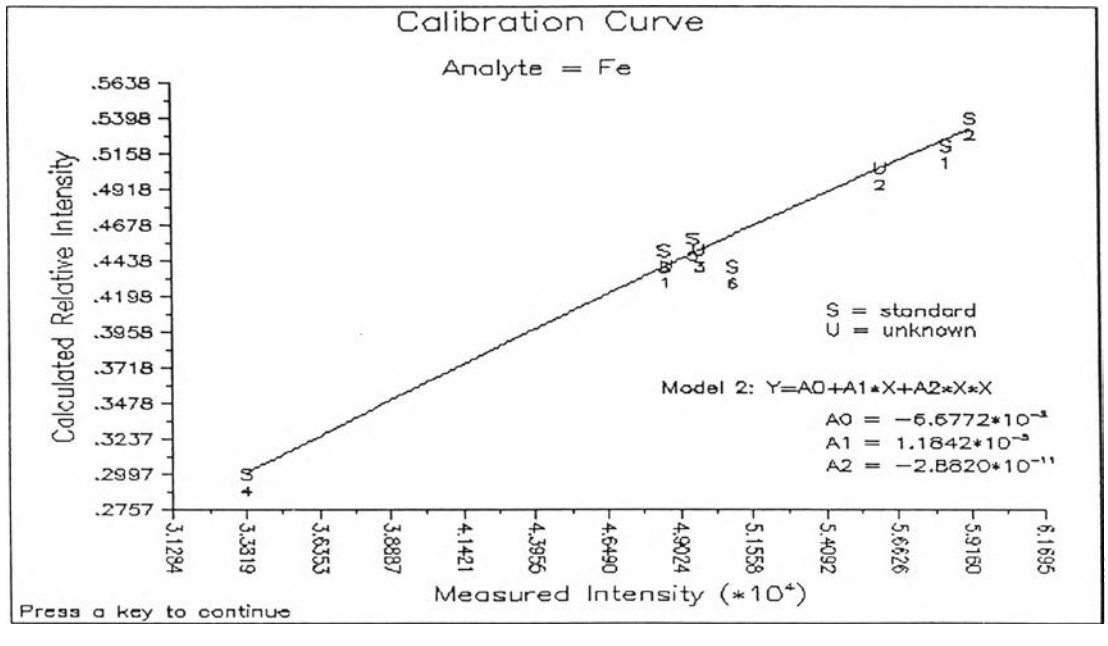
Date: 05-13-1998

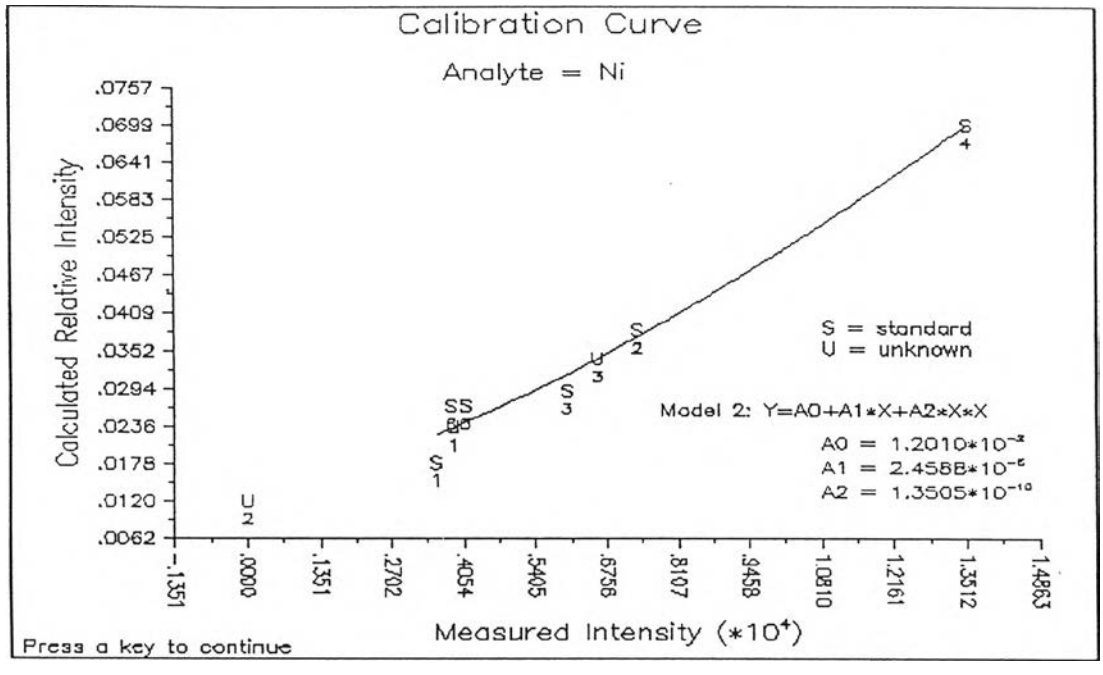
Start time: 20:14:45 End time: 20:18:21

Stop - Program terminated.

กราฟปรับเทียบ (Stainless Steel)



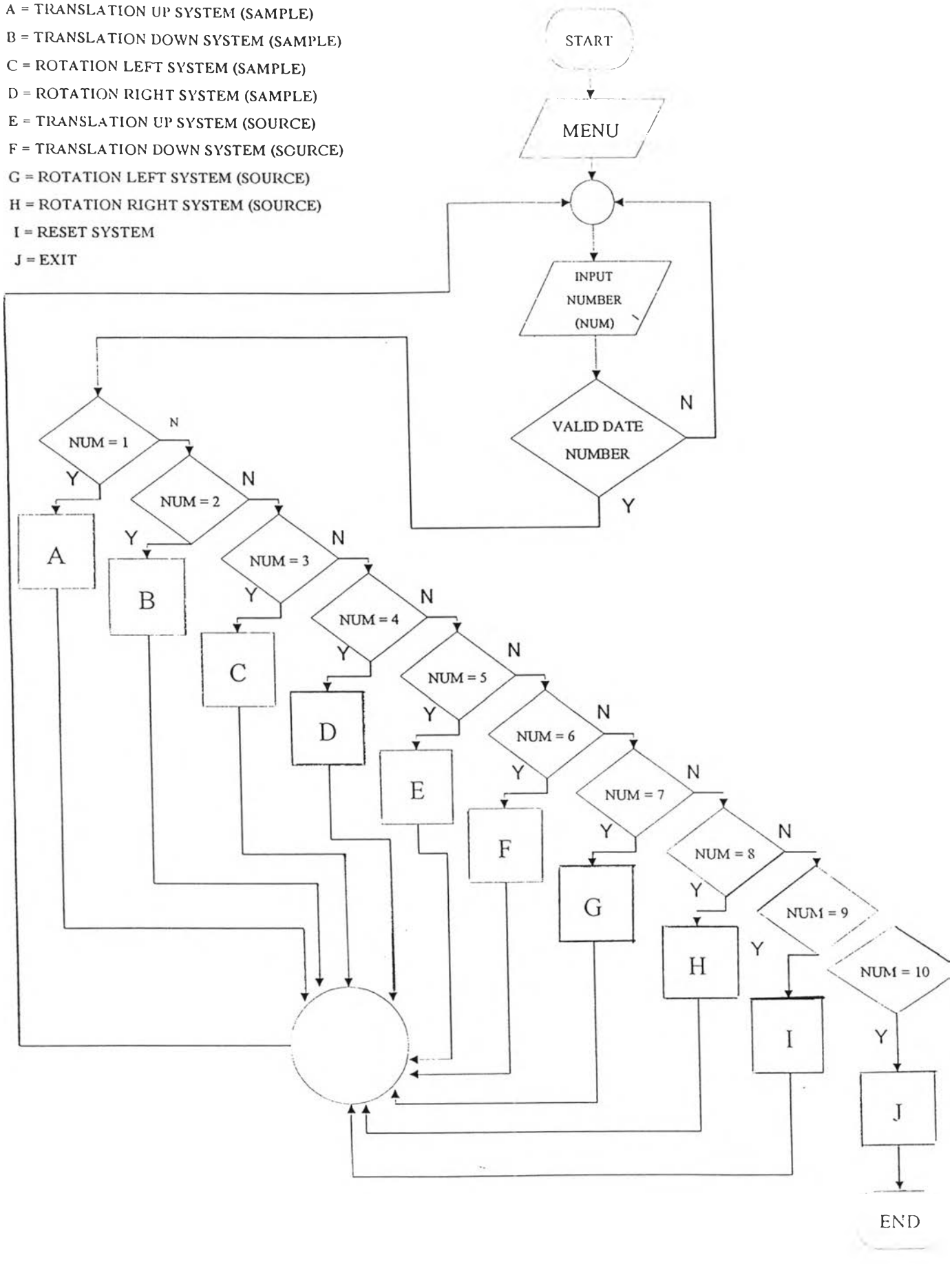



Calibration Curve
Analyte = Ni
Calculated Relative Intensity
.0757
.0699
.0641
.0583
.0525
.0467
.0409
.0352
.0294
.0236
.0178
.0120
.0062
S = standard
U = unknown
Model 2: Y=A0+A1*X+A2*X*X
A0 = 1.2010*10^-4
A1 = 2.4588*10^-5
A2 = 1.3505*10^-10
-.1351
.0000
.1351
.2702
.4054
.5405
.6756
.8107
.9458
1.0810
1.2161
1.3512
1.4863
Measured Intensity (*10^4)
Press a key to continue

ภาคผนวก ค.

Flow Chart และโปรแกรมควบคุมการทำงานของเครื่องเปลี่ยนต้นกำเนิดรังสีกระตุ้น และเครื่องเปลี่ยนตัวอย่าง

A = TRANSLATION UP SYSTEM (SAMPLE)
B = TRANSLATION DOWN SYSTEM (SAMPLE)
C = ROTATION LEFT SYSTEM (SAMPLE)
D = ROTATION RIGHT SYSTEM (SAMPLE)
E = TRANSLATION UP SYSTEM (SOURCE)
F = TRANSLATION DOWN SYSTEM (SOURCE)
G = ROTATION LEFT SYSTEM (SOURCE)
H = ROTATION RIGHT SYSTEM (SOURCE)
I = RESET SYSTEM
J = EXIT



```
'----------start main----------
1 :     GOSUB displayandselectmenu
        PRINT
        ON num GOSUB a, b, c, d, e, f, g, h, i, J
        PRINT
        GOTO 1:
'----------end main----------

displayandselectmenu:
2 :     CLS
        PRINT
        LOCATE 5, 16: PRINT "------------------------------"
        LOCATE 6, 16: PRINT "     main menu"
        LOCATE 7, 16: PRINT "------------------------------"
        LOCATE 9, 16: PRINT "1. translation up of sample"
        LOCATE 10, 16: PRINT "2. translation down of sample"
        LOCATE 11, 16: PRINT "3. rotation left of sample"
        LOCATE 12, 16: PRINT "4. rotation right of sample"
        LOCATE 13, 16: PRINT "5. translation up of source"
        LOCATE 14, 16: PRINT "6. translation down of source"
        LOCATE 15, 16: PRINT "7. rotation left of source"
        LOCATE 16, 16: PRINT "8. rotation right of source"
        LOCATE 17, 16: PRINT "9. reset system ( to origin )"
        LOCATE 18, 16: PRINT "10. EXIT"
        LOCATE 20, 16: PRINT "------------------------------"
        PRINT
        LOCATE 22, 10: INPUT "select number from the menu"; num
        GOSUB validdatenumber
        RETURN

a:
    OUT 779, 137
'1 lp = 4 step: 1 step = 1.8 degree'
INPUT "distance of up translation(sample)"; Y
PRINT " Y = "; Y; "mm."
delay = 300: lp = 1221 * Y
    FOR J = 1 TO lp
    OUT 777, 48: FOR i = 1 TO delay: NEXT i
    OUT 777, 96: FOR i = 1 TO delay: NEXT i
    OUT 777, 192: FOR i = 1 TO delay: NEXT i
    OUT 777, 144: FOR i = 1 TO delay: NEXT i
```

```
    NEXT J
    RETURN

b:
    OUT 779, 137
'1 lp = 4 step: 1 step = 1.8 degree'
INPUT "distance of down translation(sample)"; Y
PRINT " Y =  "; Y; "mm."
delay = 300: lp = 1221 * Y
    FOR J = 1 TO lp
    OUT 777, 48: FOR i = 1 TO delay: NEXT i
    OUT 777, 144: FOR i = 1 TO delay: NEXT i
    OUT 777, 192: FOR i = 1 TO delay: NEXT i
    OUT 777, 96: FOR i = 1 TO delay: NEXT i
    NEXT J
    RETURN

c:
    OUT 775, 137
'1 lp = 4 step: 1 step = 1.8 degree'
INPUT "distance of left rotation(sample)"; X
PRINT " X =  "; X; "step"
delay = 400: lp = 300 * X
    FOR J = 1 TO lp
    OUT 773, 3: FOR i = 1 TO delay: NEXT i
    OUT 773, 9: FOR i = 1 TO delay: NEXT i
    OUT 773, 12: FOR i = 1 TO delay: NEXT i
    OUT 773, 6: FOR i = 1 TO delay: NEXT i
    NEXT J
    RETURN

d:
    OUT 775, 137
'1 lp = 4 step: 1 step = 1.8 degree'
INPUT "distance of right rotation(sample)"; X
PRINT " X =  "; X; "step"
delay = 400: lp = 300 * X
    FOR J = 1 TO lp
    OUT 773, 3: FOR i = 1 TO delay: NEXT i
    OUT 773, 6: FOR i = 1 TO delay: NEXT i
    OUT 773, 12: FOR i = 1 TO delay: NEXT i
```

```
    OUT 773, 9: FOR i = 1 TO delay: NEXT i
    NEXT J
    RETURN

e:
    OUT 775, 137
'1 lp = 4 step: 1 step = 1.8 degree'
INPUT "distance of up translation(source)"; Y
PRINT " Y = "; Y; "mm."
delay = 300: lp = 1221 * Y
    FOR J = 1 TO lp
    OUT 772, 3: FOR i = 1 TO delay: NEXT i
    OUT 772, 6: FOR i = 1 TO delay: NEXT i
    OUT 772, 12: FOR i = 1 TO delay: NEXT i
    OUT 772, 9: FOR i = 1 TO delay: NEXT i
    NEXT J
    RETURN

f:
    OUT 775, 137
'1 lp = 4 step: 1 step = 1.8 degree'
INPUT "distance of down translation(source)"; Y
PRINT " Y = "; Y; "mm."
delay = 300: lp = 1221 * Y
    FOR J = 1 TO lp
    OUT 772, 3: FOR i = 1 TO delay: NEXT i
    OUT 772, 9: FOR i = 1 TO delay: NEXT i
    OUT 772, 12: FOR i = 1 TO delay: NEXT i
    OUT 772, 6: FOR i = 1 TO delay: NEXT i
    NEXT J
    RETURN

g:
    OUT 779, 137
'1 lp = 4 step: 1 step = 1.8 degree'
INPUT "distance of left rotation(source)"; X
PRINT " X = "; X; "step"
delay = 400: lp = 300 * X
    FOR J = 1 TO lp
    OUT 776, 48: FOR i = 1 TO delay: NEXT i
    OUT 776, 144: FOR i = 1 TO delay: NEXT i
```

```
    OUT 776, 192: FOR i = 1 TO delay: NEXT i
    OUT 776, 96: FOR i = 1 TO delay: NEXT i
    NEXT J
    RETURN

h:
    OUT 779, 137
'1 lp = 4 step: 1 step = 1.8 degree'
INPUT "distance of right rotation(source)"; X
PRINT " X =  "; X; "step"
delay = 400: lp = 300 * X
    FOR J = 1 TO lp
    OUT 776, 48: FOR i = 1 TO delay: NEXT i
    OUT 776, 96: FOR i = 1 TO delay: NEXT i
    OUT 776, 192: FOR i = 1 TO delay: NEXT i
    OUT 776, 144: FOR i = 1 TO delay: NEXT i
    NEXT J
    RETURN

i:  GOTO RESETALL

J:
    PRINT "SYSTEM COMPLETE"
    END

validdatenumber:
        IF num > 0 AND num < 11 THEN RETURN
        GOTO 2:
RESETALL:
      OUT 775, 137
      OUT 779, 137
PRINT " PLEASE WAIT... STARTING RESET SYSTEM NOW! "
      GOSUB RESETTRAN1
      GOSUB RESETROT1
      GOSUB RESETROT2
      GOSUB RESETTRAN2
PRINT " RESET SYSTEM COMPLETE "
      GOTO 2:
```

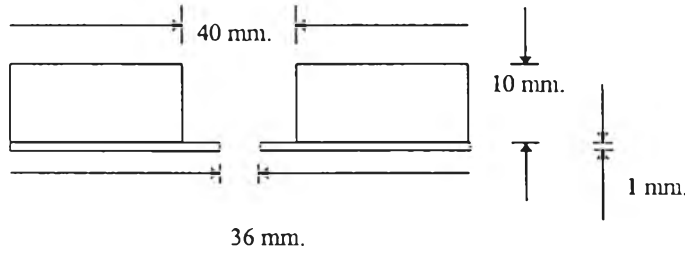
```
RESETTRAN1:

'1 lp = 4 step: 1 step = 1.8 degree'
PRINT " PLEASE WAIT... RESET (SOURCE TRANSLATION SYSTEM) NOW! "
delay = 300: lp = 20000
    FOR J = 1 TO lp
    OUT 772, 3: FOR i = 1 TO delay: NEXT i
    Z = (8 AND INP(778)): IF Z = 8 THEN RETURN
    OUT 772, 9: FOR i = 1 TO delay: NEXT i
    Z = (8 AND INP(778)): IF Z = 8 THEN RETURN
    OUT 772, 12: FOR i = 1 TO delay: NEXT i
    Z = (8 AND INP(778)): IF Z = 8 THEN RETURN
    OUT 772, 6: FOR i = 1 TO delay: NEXT i
    Z = (8 AND INP(778)): IF Z = 8 THEN RETURN
    NEXT J

RESETROT1:

'1 lp = 4 step: 1 step = 1.8 degree'
PRINT " PLEASE WAIT... RESET(SOURCE ROTATION SYSTEM) NOW! "
delay = 300: lp = 2400
    FOR J = 1 TO lp
    OUT 776, 48: FOR i = 1 TO delay: NEXT i
    Z = (2 AND INP(774)): IF Z = 2 THEN RETURN
    OUT 776, 96: FOR i = 1 TO delay: NEXT i
    Z = (2 AND INP(774)): IF Z = 2 THEN RETURN
    OUT 776, 192: FOR i = 1 TO delay: NEXT i
    Z = (2 AND INP(774)): IF Z = 2 THEN RETURN
    OUT 776, 144: FOR i = 1 TO delay: NEXT i
    Z = (2 AND INP(774)): IF Z = 2 THEN RETURN
    NEXT J

RESETROT2:

'1 lp = 4 step: 1 step = 1.8 degree'
PRINT " PLEASE WAIT... RESET(SAMPLE ROTATION SYSTEM) NOW! "
delay = 300: lp = 2400
    FOR J = 1 TO lp
    OUT 773, 3: FOR i = 1 TO delay: NEXT i
    Z = (4 AND INP(778)): IF Z = 4 THEN RETURN
    OUT 773, 6: FOR i = 1 TO delay: NEXT i
```

```
    Z = (4 AND INP(778)): IF Z = 4 THEN RETURN
    OUT 773, 12: FOR i = 1 TO delay: NEXT i
    Z = (4 AND INP(778)): IF Z = 4 THEN RETURN
    OUT 773, 9: FOR i = 1 TO delay: NEXT i
    Z = (4 AND INP(778)): IF Z = 4 THEN RETURN
    NEXT J

RESETTRAN2:

'1 lp = 4 step: 1 step = 1.8 degree'
PRINT " PLEASE WAIT... RESET(SAMPLE TRANSLATION SYSTEM) NOW! "
delay = 300: lp = 20000
    FOR J = 1 TO lp
    OUT 777, 48: FOR i = 1 TO delay: NEXT i
    Z = (1 AND INP(774)): IF Z = 1 THEN RETURN
    OUT 777, 144: FOR i = 1 TO delay: NEXT i
    Z = (1 AND INP(774)): IF Z = 1 THEN RETURN
    OUT 777, 192: FOR i = 1 TO delay: NEXT i
    Z = (1 AND INP(774)): IF Z = 1 THEN RETURN
    OUT 777, 96: FOR i = 1 TO delay: NEXT i
    Z = (1 AND INP(774)): IF Z = 1 THEN RETURN
    NEXT J
```

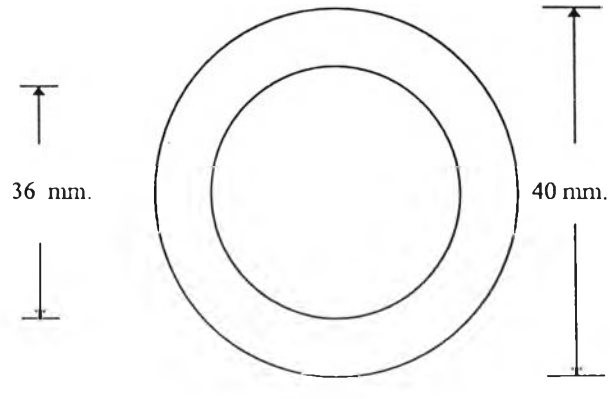
ภาคผนวก ง.

ก.) จานเปลี่ยนต้นกำเนิดรังสีกระตุ้น

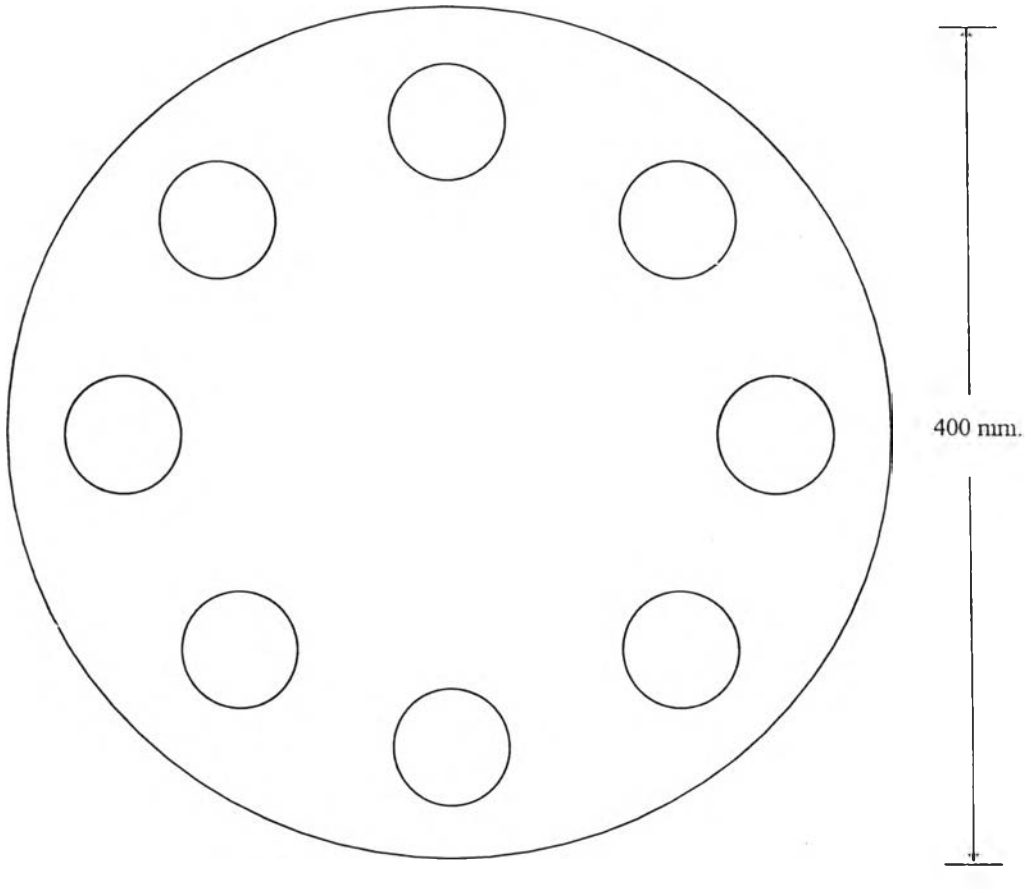
<u>ขนาดของหลุมใส่ต้นกำเนิดรังสีกระตุ้น</u> (SIDE VIEW)



<u>ขนาดของหลุมใส่ต้นกำเนิดรังสีกระตุ้น</u> (TOP VIEW)

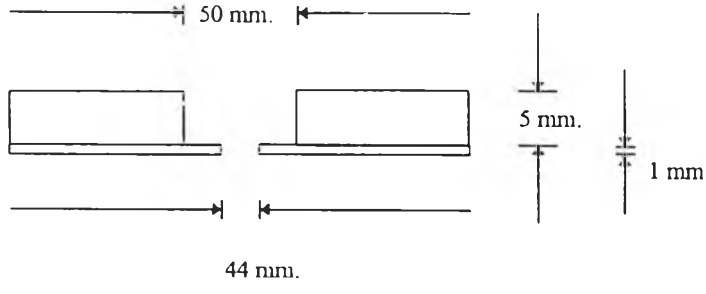


ขนาดของจานเปลี่ยนต้นกำเนิดรังสีกระตุ้น (TOP VIEW)

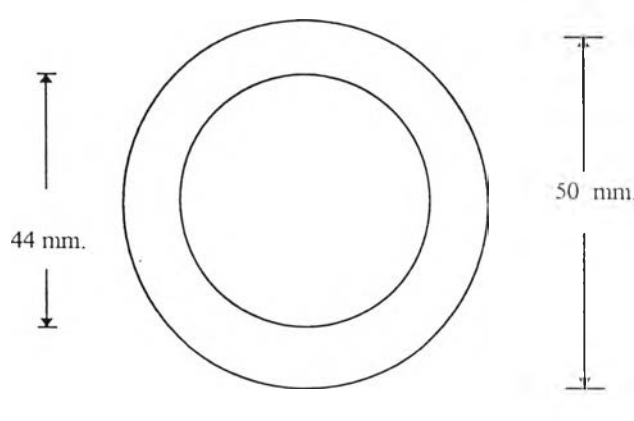


ข.) จานเปลี่ยนตัวอย่าง

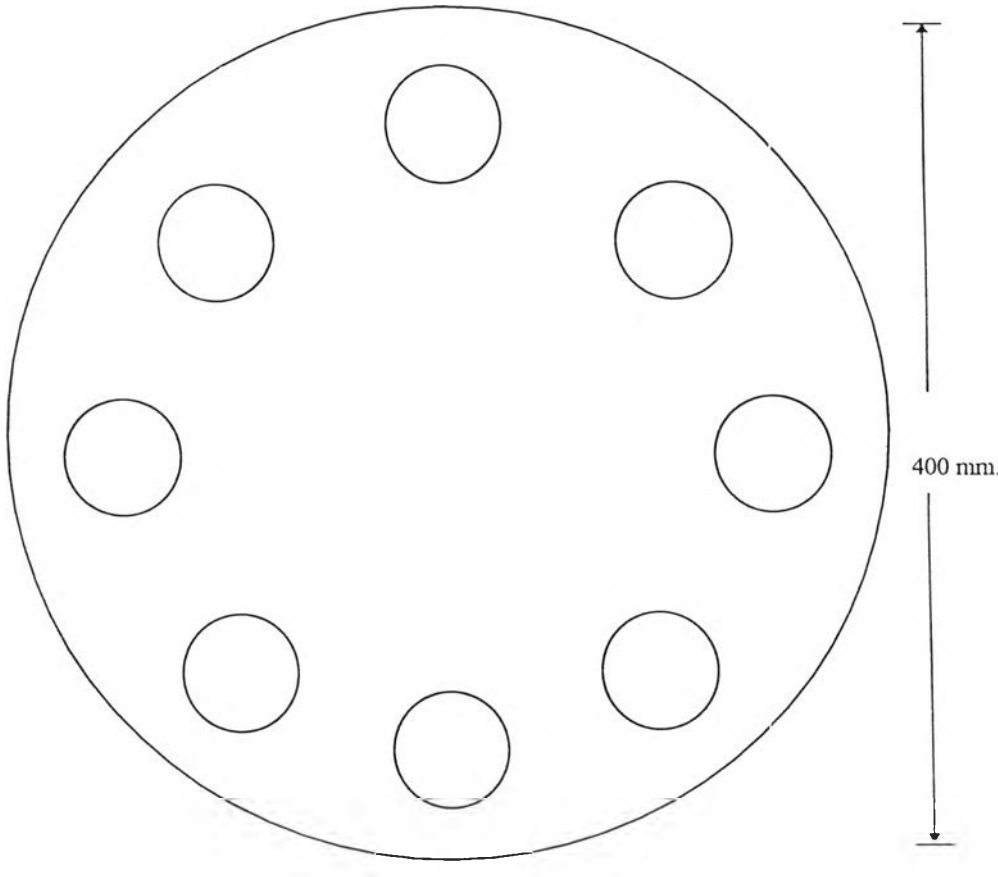
ขนาดของหลุมใส่ตัวอย่าง (SIDE VIEW)



ขนาดของหลุมใส่ตัวอย่าง (TOP VIEW)



ขนาดของจานใส่ตัวอย่าง (TOP VIEW)



ประวัติผู้เขียน

นายธนพงษ์ ทองประพาฬ เกิดเมื่อวันที่ 12 มิถุนายน 2515 สถานที่เกิด กรุงเทพมหานคร สำเร็จการศึกษาระดับปริญญาตรี วิทยาศาสตรบัณฑิต (วิชาเอกฟิสิกส์) จากมหาวิยาลัยศรีนครินทรวิโรฒ วิทยาเขตุกลางประสานมิตร เมื่อปี พ.ศ. 2536