united nations
educational, scientific
and cultural
organization

international atomic
energy agency

the
abdus salam
international centre for theoretical physics

SMR.1148 - 16

COLLEGE ON MEDICAL PHYSICS
AND
WORKSHOP ON
NUCLEAR DATA FOR SCIENCE AND TECHNOLOGY:
MEDICAL APPLICATIONS
(20 SEPTEMBER - 15 OCTOBER 1999)

"Computerized System for QC Measurements in Diagnostic Radiology"

Slavik TABAKOV
Kings College
School of Medicine
Medical Physics Department
Denmark Hill
London SE5 9RS
U.K.

PRACTICAL QUALITY CONTROL IN DIAGNOSTIC RADIOLOGY
Computerised system for QC measurements with EXCEL

ABSTRACT

The aim of Quality Control (QC) is to ensure continuing production of diagnostic images with optimium quality, using minimum necessary dose to the patient. QC should include checks and test measurements on all parts of the X-ray imaging system at intervals not exceeding one year. In the UK practice the X-ray Radiographic equipment (X-ray tube and generator) is tested at least once per year.

The main parameters to be monitored during the routine QC of Radiography include:

Dose consistency	Timer consistency
Dose variation with mA	Timer accuracy
Dose variation with kV	Beam filtration (HVL)
kV consistency	Focal Spot size
kV accuracy	Beam alignment
kV variation with mA	Leakage radiation

Use of kVp and Dose waveforms for assessing the ripple and other parameters is also recommended.

It is useful to use of a spreadsheet program (eg. Microsoft EXCEL) for designing a simple QC spreadsheet. Such spreadsheet needs to have a sheet for the raw data and a "hidden" sheet where all necessary calculation and intermediate results are made. The calculated QC parameters are shown together with the reference data on a separate "result page".

Real examples of use of an EXCEL Diagnostic Radiology QC spreadsheet are shown on the next pages (appendix 1 and 2). These are divided to parts to show consecutively parts of the "raw data page" and the "result page" together with graphical representation of results. A list with "normal" values of some of the QC parameters, based on statistics of 100 radiographic sets is also shown in Appendix 3.

The exact procedures for performing Radiographic QC are given in the EMERALD Training Materials (EMERALD - Physics of X-ray Diagnostic Radiology; ISBN 1870722043, S.Tabakov, Emerald Consortium; King's College London, 1999)

Dr S.Tabakov

APPENDIX 1

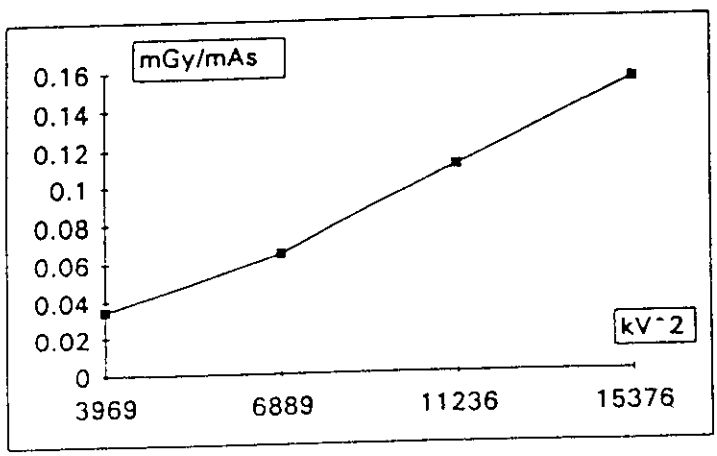
X-RAY GENERATOR AND TUBE MEASUREMENTS

These measurements were made with a keithley kVp divider s/n 27775, digital storage oscilloscope Gould 450 s/n 14400056, and an MDH electrometer s/n 3011with 6 cc chamber .

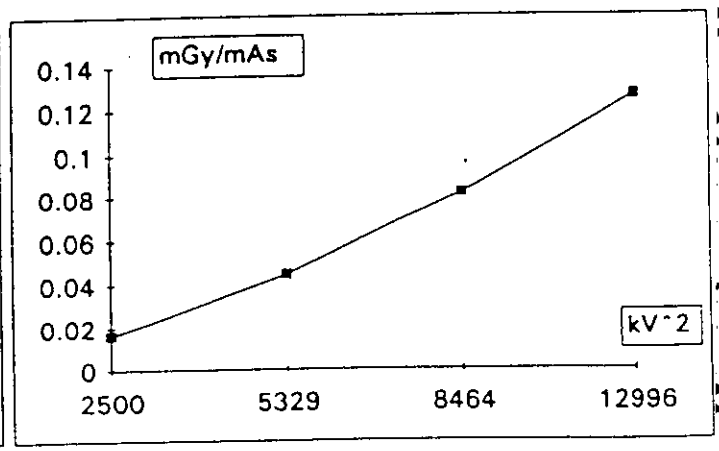
						FDD(cm) =	100
Focus	Set kV (kV)	Set mA (mA)	Set Time (ms)	Set mAs (mAs)	Meas kV (kV)	Meas T (ms)	Meas exp (mR)	Air kerma (mGy)
Broad	60	300	80	24	63	81	95	0.83
B	80	300	80	24	83	81	177	1.54
B	100	300	80	24	106	84	304	2.64
B	120	300	80	24	124	86	426	3.70
Fine	50	100	200	20	50	192	37	0.32
F	70	100	200	20	73	205	102	0.89
F	90	100	200	20	92	208	188	1.63
F	110	100	200	20	114	208	291	2.53

Parameter	Unit	Expected	Measured	Assessment
kVp accuracy (BF)	(%) inaccuracy	-10<A<10	4.5	Good
kVp accuracy (FF)	(%) inaccuracy	-10<A<10	2.5	Good
	St.dev.		1.82	
Specific O'put-80kV(BF)	(uGy/mAs) @ 1m	30<A<70	63.20	Normal
Specific O'put-80kV(FF)	(uGy/mAs) @ 1m	30<A<70	63.21	Normal
Ripple at 100kV (BF)	+/- kVp ampl	5	9	Accept

Radiation output variation with kV (BF)



Radiation output variation with kV (FF)



Beam/LBD Alignement	displacement (cm)	<1	~1	! !
Bucky centering	displacement (cm)	<1	<1	
Focus size (mm)	Broad Focus-(BF)	1	1X0.8	Accept
	Fine Focus-(FF)	0.6	0.5x0.5	Accept
Maximum leakage	(mGy/min)			Accept

APPENDIX 2

X-RAY GENERATOR AND TUBE MEASUREMENTS

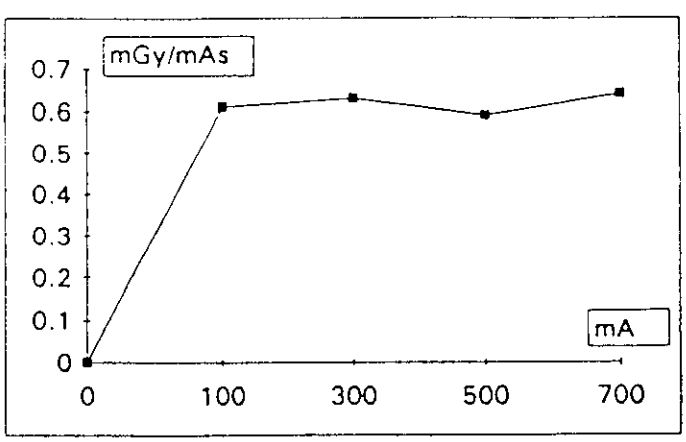
These measurements were made with a keithley kVp divider s/n 27775, digital storage oscilloscope Gould 450 s/n 14400056, and an MDH electrometer s/n 3011with 6 cc chamber .

							FDD(cm) =	100
Focus	Set kV (kV)	Set mA (mA)	Set Time (ms)	Set mAs (mAs)	Meas kV (kV)	Meas T (ms)	Meas exp (mR)	Air kerma (mGy)
B	80	300	80	24	83	81	177	1.54
B	80	300	80	24	81	81	176	1.53
B	80	300	80	24	80	82	177	1.54
B	80	300	80	24	80	81	176	1.53
B	80	300	80	24	81	80	175	1.52
B	80	500	80	40	79	81	268	2.33
B	80	700	80	56	80	80	422	3.67
B	80	300	20	6	82	24	52.6	0.46
B	80	300	400	120	80	418	897	7.79
B	80	300	800	240	84	820	1730	15.03

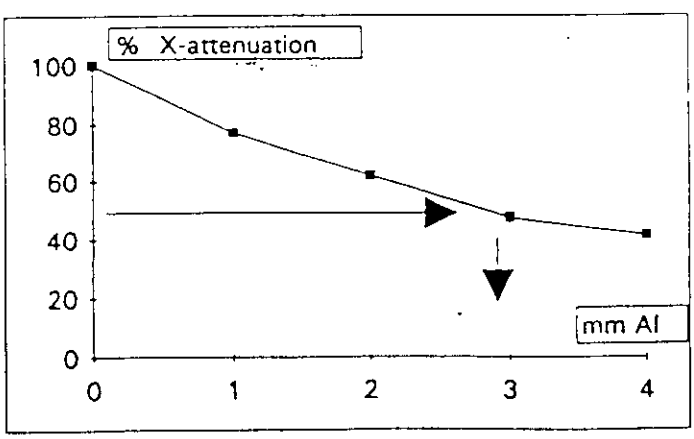
Parameter	Unit	Expected	Measured	Assessment
kVp consistency (BF)	(%) inconsist.	<5	1.7	Good
Timer consistency (BF)	(%) inconsist.	<5	0.71	Good
O'put consistency(BF)	(%) inconsist.	<5	0.3	Good
kVp var'n with mA (BF)	(%) variation	<10	1.25	Good
O'put var'n with mA(BF)	(%) variation	<10	5.99	Normal
Timer accuracy (BF)	(%) inaccuracy	-10<A<10	9.00	Normal

		Half Value Layer Measurements are shown below						
B+0mm Al	80	300	80	24			176	1.53
B+0mm Al	80	300	80	24			175	1.52
B+1mm Al	80	300	80	24			135	1.17
B+2mm Al	80	300	80	24			109	0.95
B+3mm Al	80	300	80	24			84	0.73
B+4mm Al	80	300	80	24			73	0.63

Radiation output variation with mA (BF)



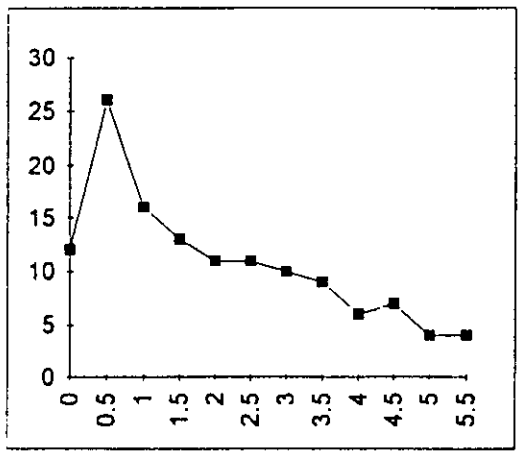
Half value layer measurement



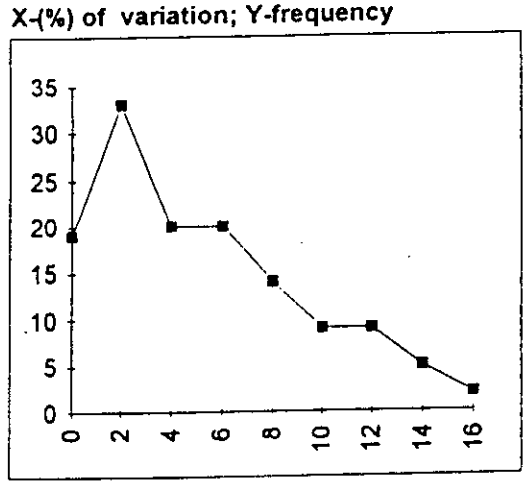
APPENDIX 3

IMPORTANT X-RAY TUBE/GEN. PARAMETERS - STATISTICAL DISTRIBUTION*

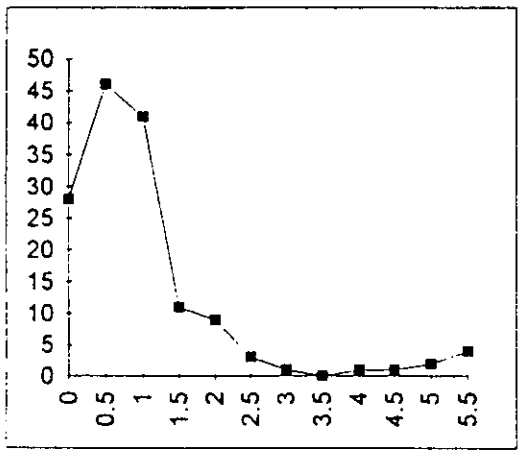
Output -mGy -consistency (BF & FF)
X - (%) of inconsistency; Y-frequency



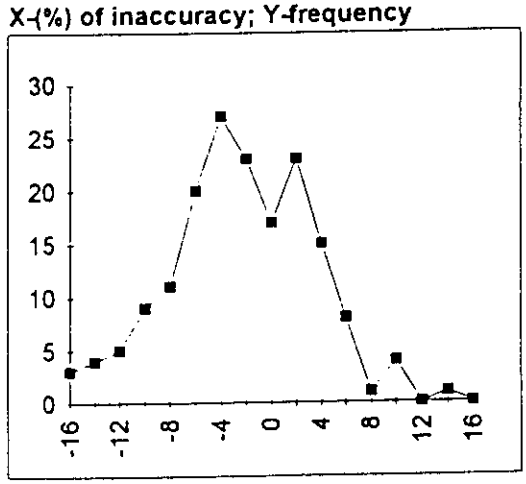
Output variation- mGy/mAs- with mA
X-(%) of variation; Y-frequency



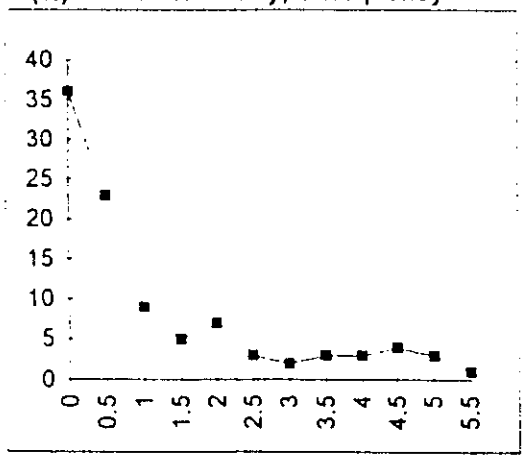
kV consistency (BF & FF)
X- (%) of inconsistency; Y-frequency



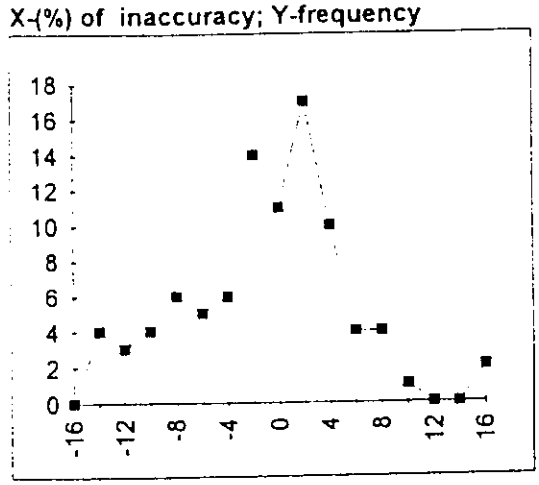
kV accuracy (BF & FF)
X-(%) of inaccuracy; Y-frequency



Timer -msec- consistency
X-(%) of inconsistency; Y-frequency



Timer -msec- accuracy
X-(%) of inaccuracy; Y-frequency



*The statistical distribution is based on data from more than 100 different sets.

S.D.Tabakov, 1996