



Necessity of monitor quality control and total management with QA software

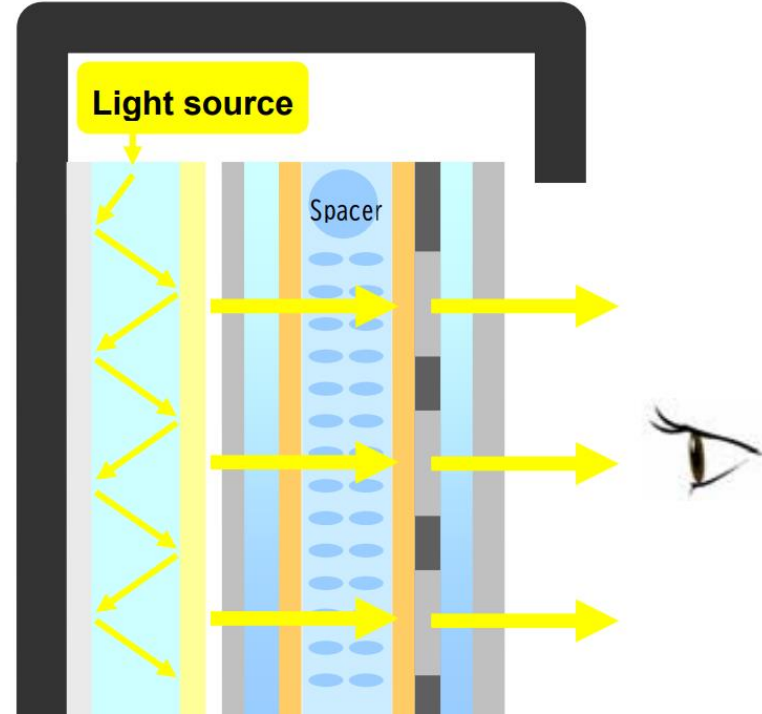
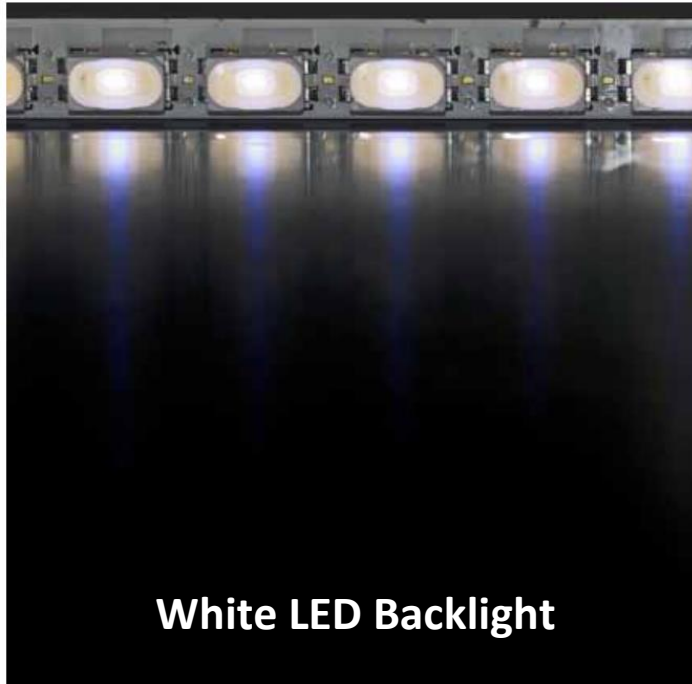
2020 Joint AAPM | COMP Virtual Meeting
Partners In Solutions program : Imaging and Diagnostic QA Software

Brian Cote
EIZO Inc.
July 14, 2020

Why is quality control needed for monitors?

Degradation of the monitor

✓ Structure of LCD monitor

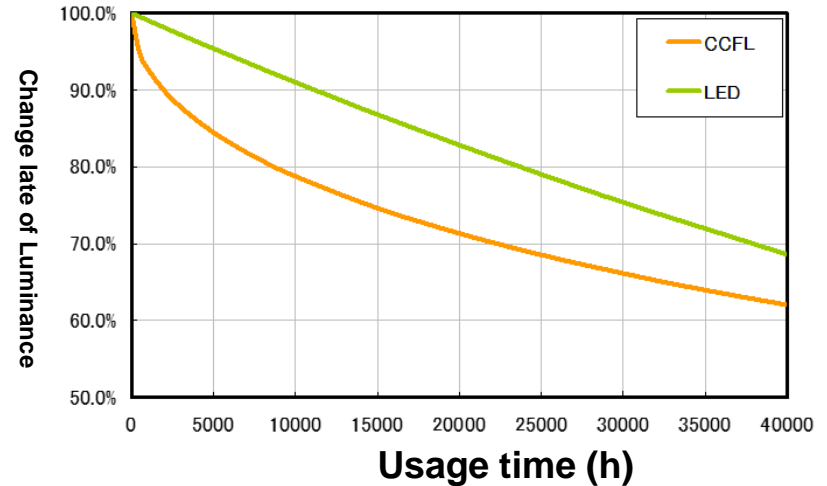


Degradation of the monitor

✓ Degradation of backlight

✓ Factor (Heat and Light)

- ✓ Phosphor
- ✓ Resin to cover the elements
- ✓ Reflector



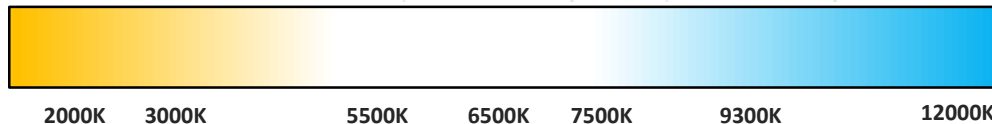
LED backlight = Long lifetime, but still degrade

Degradation of the monitor

✓ Other factors of imaging quality

✓ Color Temperature

- ✓ Color will change over time
- ✓ Native color temperature of LCD panel is NOT constant between individual units
- ✓ Color monitor can be calibrated with targeted color temperature

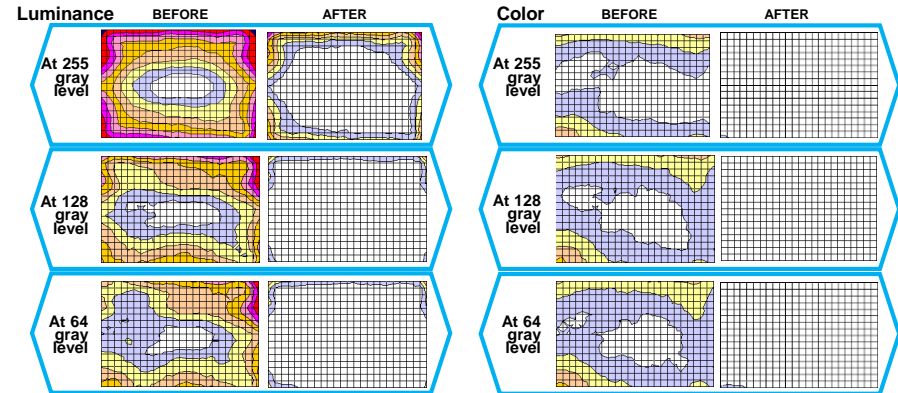
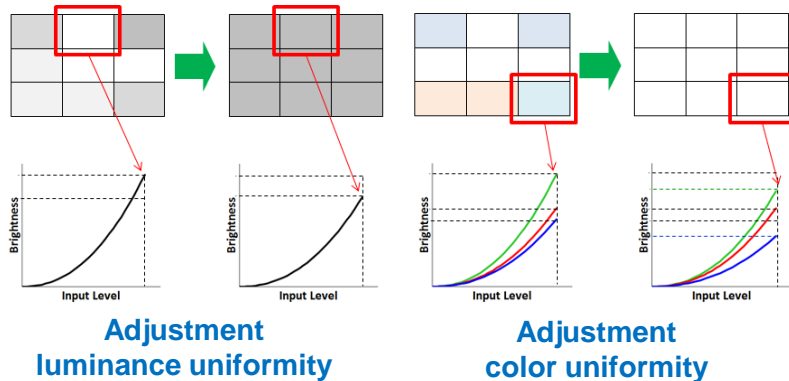


Degradation of the monitor

✓ Other factors of imaging quality

✓ Uniformity of Luminance and Color

- ✓ Native LCD panel has fluctuations in luminance and color
- ✓ EIZO even out fluctuations by Digital Uniformity Equalizer function



Effect of monitor degradation

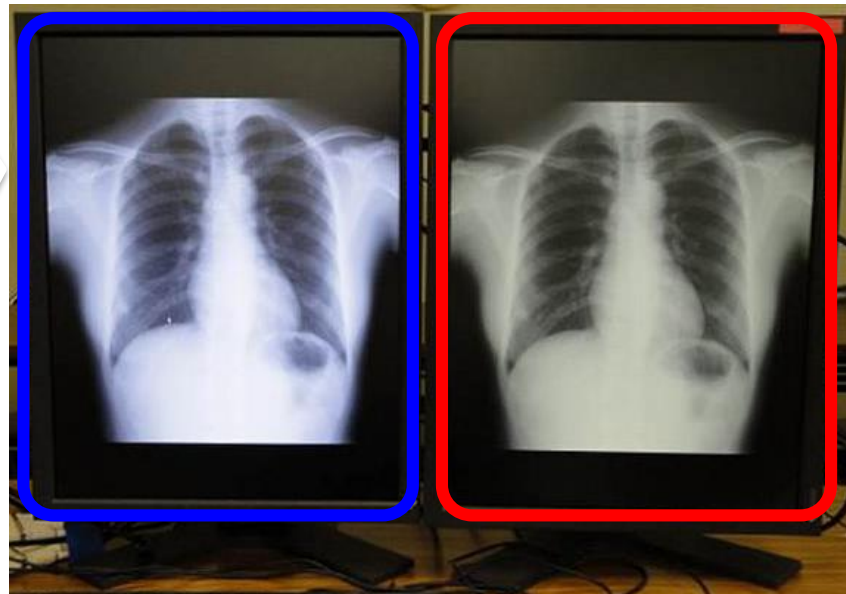
✓ Example

After 6 months

【Usage Time】
4,000 h

【Luminance】
383cd/m²

※Original: 400cd/m²



After 5.5 years

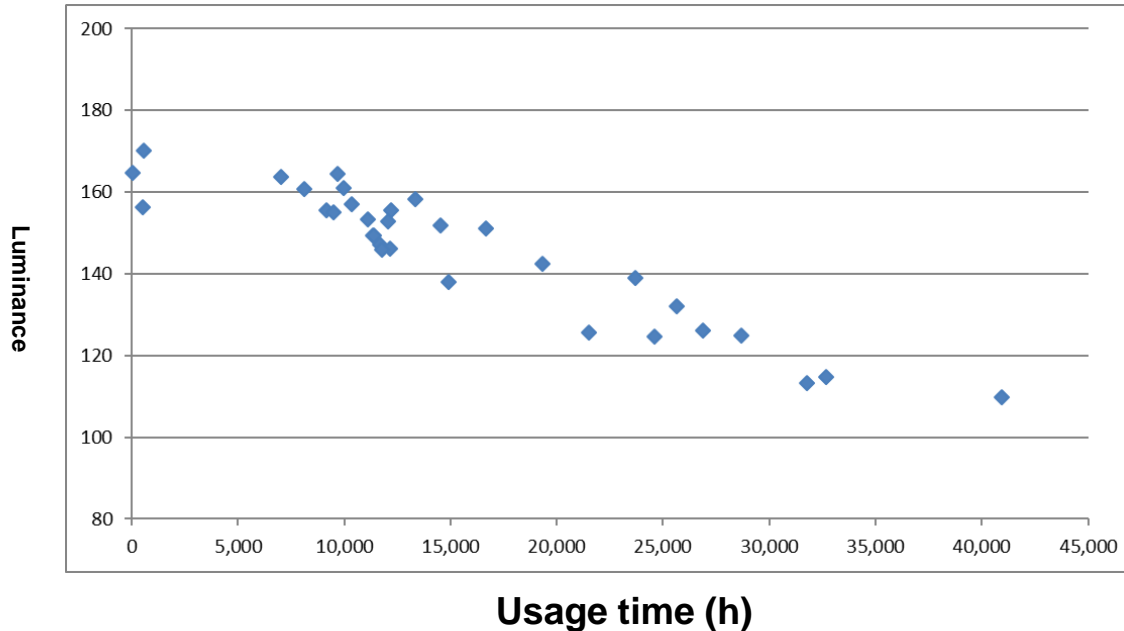
【Usage Time】
55,000 h

【Luminance】
216cd/m²

※Original: 400cd/m²

Effect of monitor degradation

✓ Example : Variation within the same facility

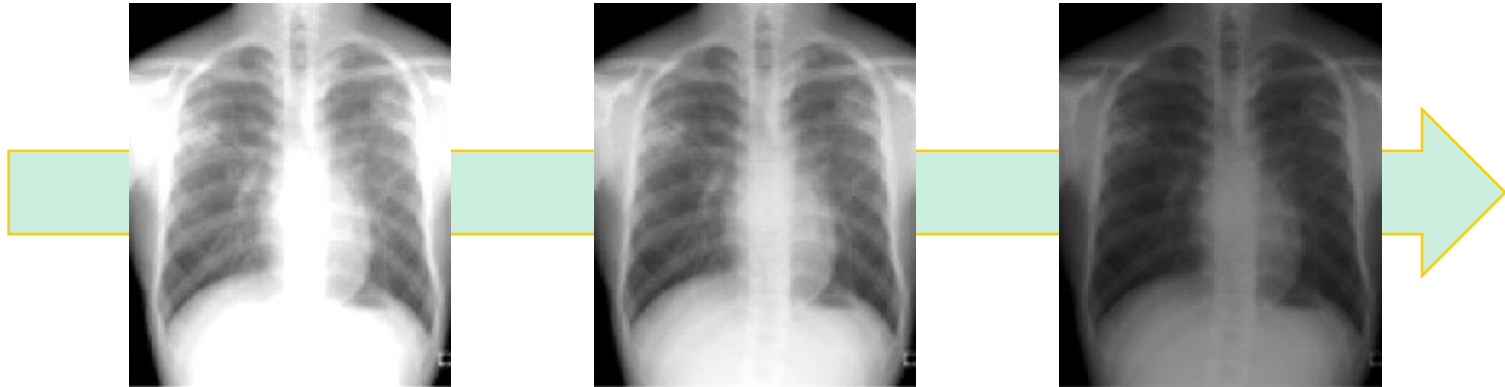


Differences occur depending on location and use

Effect of monitor degradation

✓ Implications for reading

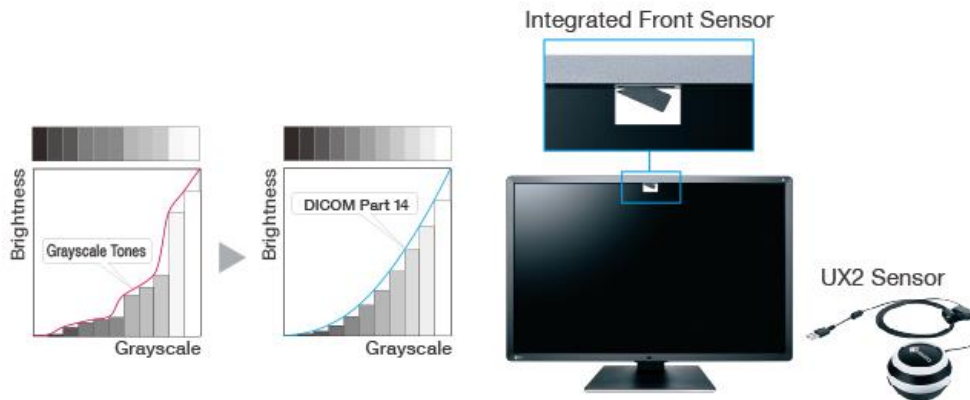
- ✓ Lack of necessary information
- ✓ Different views between different monitors
- ✓ Different views between different times



Calibration

✓ Elements of Calibration

- ✓ Luminance
- ✓ Gamma - Tone Curve
- ✓ Color Temperature (Color monitor only)

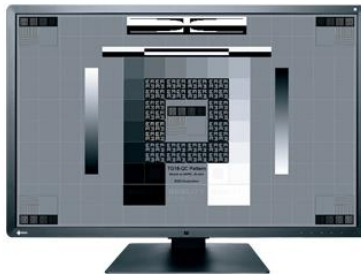


Monitor QC/QA Testing

✓ What is required?

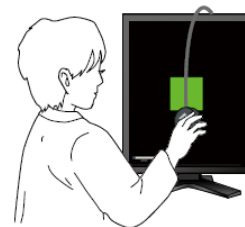
✓ Acceptance Test / Consistency Test

✓ Pattern Check



✓ Measurement Check

- ✓ Luminance
- ✓ Grayscale
- ✓ Uniformity



Monitor QC/QA Standards

✓ Famous standards

- ✓ AAPM On-Line Report No.03 (TG18) : 2005
- ✓ NYC Quality Assurance Guidelines
for Primary Diagnostic Monitors : 2015
- ✓ ACR–AAPM–SIIM Technical Standard
for Electronic Practice of Medical Imaging : 2017
- ✓ Display Quality Assurance: Recommendations
from AAPM TG270 : 2019

Monitor QC/QA Standards

✓ Examples of criteria : from NYC PDM guidelines

Acceptance Test

- A quantitative test to be completed at first install or when the environment changes. Also done yearly.

	NYC – Hospitals	NYC – Clinical Sites	NYC – Mammography
Luminance Check	L'max / L'min > 250 L'max > 350 cd/m2 Lamb < Lmin / 1.5	L'max / L'min > 250 L'max > 250 cd/m2 Lamb < Lmin / 1.5	L'max / L'min > 250 L'max > 420 cd/m2 Lamb < Lmin / 1.5
Grayscale Check	Target error rate < 10% of GSDF	Target error rate < 10% of GSDF	Target error rate < 10% of GSDF
Uniformity Check	Gayscale: 204, 26 (Lmax-Lmin) / (Lmax+Lmin) x 200 < 30%	Gayscale: 204, 26 (Lmax-Lmin) / (Lmax+Lmin) x 200 < 30%	Gayscale: 204, 26 (Lmax-Lmin) / (Lmax+Lmin) x 200 < 30%

Bi-weekly Test

- A subjective test completed every other week to ensure the image performance is maintained.

	NYC – Hospitals	NYC – Clinical Sites	NYC – Mammography
Pattern Check (Used pattern)	Black SMPTE Shades of RGB White	Black SMPTE Shades of RGB White	Black SMPTE Shades of RGB White

Consistency Test

- A quantitative test done quarterly to ensure the monitors are maintain luminance output and adherence to the DICOM GSDF gamma curve

	NYC – Hospitals	NYC – Clinical Sites	NYC – Mammography
Luminance Check	L'max / L'min > 250 L'max > 350 cd/m2 Lamb < Lmin / 1.5	L'max / L'min > 250 L'max > 250 cd/m2 Lamb < Lmin / 1.5	L'max / L'min > 250 L'max > 420 cd/m2 Lamb < Lmin / 1.5
Grayscale Check	Target error rate < 10% of GSDF	Target error rate < 10% of GSDF	Target error rate < 10% of GSDF

Monitor QC/QA Standards

✓ Comparison: TG18 / ACR-AAPM-SIIM 2017 / TG270

✓ Main Criteria: Luminance, Contrast, Luminance Response

	TG18		ACR-AAPM-SIIM 2017			TG270		
	Primary	Secondary	Diagnostic for Mammogram	Diagnostic for Interpretation	Other purpose	Mammography	Diagnostic (Non-Mammography)	Modality/Clinical/EHR
Minimum Luminance	-	-	L' min $\geq 1.2\text{cd/m}^2$	L' min $\geq 1.0\text{cd/m}^2$	L' min $\geq 0.8\text{cd/m}^2$	L' min $\geq 1.2\text{cd/m}^2$	L' min $\geq 1.0\text{cd/m}^2$	L' min $\geq 0.8\text{cd/m}^2$
Contrast Ratio	≥ 250	≥ 100	350 [≥ 250]	350 [≥ 250]	350 [≥ 250]	350 [250-450]	350 [250-450]	350 [250-450]
Maximum Luminance	L' max $\geq 170\text{cd/m}^2$	L' max $\geq 100\text{cd/m}^2$	L' max $\geq 420\text{cd/m}^2$	L' max $\geq 350\text{cd/m}^2$	L' max $\geq 250\text{cd/m}^2$	L' max $\geq 420\text{cd/m}^2$ [$\geq 350\text{cd/m}^2$]	L' max $\geq 350\text{cd/m}^2$ [$\geq 300\text{cd/m}^2$]	L' max $\geq 250\text{cd/m}^2$ [$\geq 200\text{cd/m}^2$]
Luminance Response	DICOM GSDF $\leq 10\%$	DICOM GSDF $\leq 20\%$	DICOM GSDF $\leq 10\%$	DICOM GSDF $\leq 10\%$	DICOM GSDF $\leq 20\%$	DICOM GSDF $\leq 10\%$	DICOM GSDF $\leq 10\%$	DICOM GSDF $\leq 20\%$

[Acceptable Ranges]

Monitor QC/QA Standards

✓ Recommended criteria(Excerpt.) : from TG270

- ✓ Luminance, Contrast, Luminance Response
 - ✓ No significant difference from ACR-AAPM-SIIM 2017 / NYC PDM
 - ✓ 350cd/m² for Diagnostic, GSDF error rate < 10% etc.
- ✓ Other elements
 - ✓ Qualitative ambient luminance / illuminance
 - ✓ Qualitative Uniformity
 - ✓ Qualitative Spatial Resolution
 - ✓ Color Assessment
 - ✓ Etc.

EIZO monitor QC/QA solution

RadiCS

Monitor QC Software

RadiCS

✓ Standalone QC/QA

- ✓ All in One QC/CA software
 - ✓ Calibration
 - ✓ QC testing in easy steps
- ✓ Accelerate monitors value
 - ✓ Improve workflow features
 - ✓ Save monitor power and lifetime



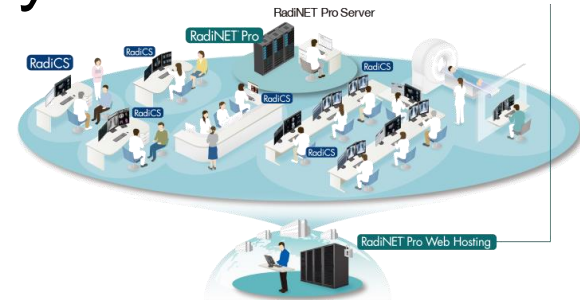
RadiNET Pro Web Hosting

Network QC Management System

RadiNET Pro Web Hosting

✓ Overview

- ✓ Connect all monitors to our server for easy QA/QC management
- ✓ Remote QC testing / Calibration / Setting
- ✓ Show all monitor's information
- ✓ Provide your settings by group policy function



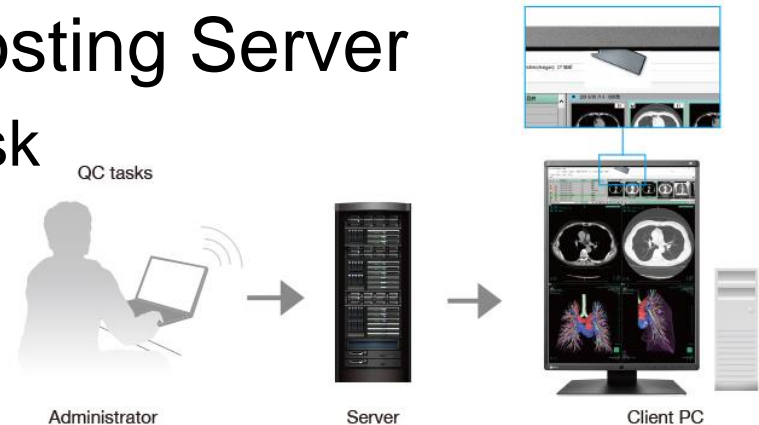
RadiNET Pro Web Hosting

✓ Manage All Monitors from Server

- ✓ Execute QC test / calibration all at once
 - ✓ Immediate execution / Scheduled Execution

✓ Record all results to Web Hosting Server

- ✓ Confirm all results on your desk
- ✓ Generate QC reports



RadiNET Pro Web Hosting

✓ Manage All Monitors from Server

✓ History List / QC Test Reports

✓ Record all action for each monitors

EJPB012-M11506

Home Device List History List Administrative Tools Options

Number of Records 20

	Date	Job	Result	QC Guideline	Tester	Monitor	Manufacturer	Model	Serial
<input type="checkbox"/>	11/22/2019 13:52	Consistency Test(Annually)	-	NYS PDM Diagnostic	Toru Ogura	EIZO	RX650	2027	
<input type="checkbox"/>	11/22/2019 13:50	Consistency Test(Quarterly)	Passed	NYS PDM Diagnostic	Toru Ogura	EIZO	RX650	2027	
<input type="checkbox"/>	11/22/2019 13:17	EIZO Monitor Settings	-	-	-	RadiNET Pro	EIZO	RX650	2027
<input type="checkbox"/>	11/22/2019 13:17	Multiple monitor setting	-	-	-	RadiNET Pro	EIZO	RX650	2027
<input type="checkbox"/>	11/22/2019 13:17	QC Guideline setting	-	-	-	RadiNET Pro	EIZO	RX650	2027
<input type="checkbox"/>	11/22/2019 13:17	Consistency Test	-	Basic QC Primary	Toru Ogura	EIZO	RX650	2027	
<input type="checkbox"/>	11/22/2019 12:36	EIZO Monitor Settings	-	-	-	RadiNET Pro	EIZO	RX650	2027
<input type="checkbox"/>	11/22/2019 12:35	QC Guideline setting	-	-	-	RadiNET Pro	EIZO	RX650	2027
<input type="checkbox"/>	11/22/2019 12:35	QC Guideline setting	-	-	-	RadiNET Pro	EIZO	RX650	2027
<input type="checkbox"/>	11/22/2019 12:35	QC Guideline setting	-	-	-	RadiNET Pro	EIZO	RX650	2027

Report

Image quality assurance in medical imaging devices
NYS PDM - Diagnostic Consistency Test (Quarterly)

date of issue 11/23/2019

Registration Information

Organization	Cypress-1
Address	
Phone Number	
Location	Office
Department	PM
Room	Tor-Web
Administrator	
Service Provider	

General Information

Standard	New York State Department of Health Bureau of Environmental Radiation Protection Guide for Radiation Safety/Quality Assurance Program Primary Diagnostic Monitor Consistency Test (Quarterly)
Monitor Type	Color LCD
Manufacturer	EIZO
Type	RX650
S/N	20706074
CAL Mode	1-DICOM
Usage Time	24H
Software	RadCS

Luminance Check

Judgment	Passed
Date	11/22/2019 1:50 PM
Tester	Toru Ogura
Sensor	Integrated Front Sensor
Lamb Measuring Device	

Measurement Result

L_{max}	$362.35cd/m^2$ $x = 0.30$ $y = 0.31$
L_{min}	$0.00cd/m^2$
Lamb	$0.00cd/m^2$

Judgment(Luminance)

Judgment	Condition	Result
Passed	$L_{max} / L_{min} > 170$	$L_{max} / L_{min} = 484.38$
Passed	$L_{max} > 171.00cd/m^2$	$L_{max} = 362.35cd/m^2$

Grayscale Check

Judgment	Passed
Date	11/22/2019 1:50 PM
Tester	Toru Ogura
Sensor	Integrated Front Sensor
Lamb Measuring Device	

RadiNET Pro Web Hosting

✓ Easy Management for Your Monitor / WS

✓ Main Screen: Monitor and Computer list

- ✓ See a wealth information
- ✓ Conveniently switch the contents
 - ✓ Easy-to-view location tree
 - ✓ Customizable columns
 - ✓ All columns has filter

Monitor		
Manufacturer	Model	Serial Number
Q	Q	Q 100
EIZO	MX192	Starts with
EIZO	MX193	= Equals
EIZO	RX350	≠ Does not equal
EIZO	RX360-AR	Q Reset

Location	Computer	Computer Status	Monitor	Usage Time			
Location	Department	Room	Manufa...	Model	Serial Number	CAL Switch ...	Usage Time
<input type="checkbox"/>	(undefined)	(undefined)	EIZO	MX193	10030046	DICOM	774
<input type="checkbox"/>	(undefined)	(undefined)	EIZO	RX360-AR	10030068	DICOM	405
<input type="checkbox"/>	(undefined)	(undefined)	EIZO	RX350	31435097	DICOM	756
<input type="checkbox"/>	(undefined)	(undefined)	EIZO	RX660	10030086	DICOM	2041
<input type="checkbox"/>	(undefined)	ECC-M04331	EIZO	RX430	00000001	DICOM/DICO	10989
<input type="checkbox"/>	(undefined)	ECC-M04331	EIZO	RX800-AR	10044114	DICOM	3587
<input type="checkbox"/>	(undefined)	ECC-VAD0	EIZO	RX680	20001112	DICOM	818
<input type="checkbox"/>	(undefined)	ECC-SUMIT7A3	EIZO	RX550	10000001	DICOM	3189
<input type="checkbox"/>	(undefined)	EPR100-M07013	EIZO	EV2780	35690038	CAL	-
<input type="checkbox"/>	(undefined)	EPR035-K0J06A	EIZO	RX650-AR	10040084	DICOM	4109
<input type="checkbox"/>	(undefined)	EPR0035-M10224	EIZO	RX660-AR	10030086	DICOM	714
<input type="checkbox"/>	(undefined)	EPR0035-M10214	EIZO	MX215	20646053	DICOM	5387
<input type="checkbox"/>	(undefined)	EPR0035-00240	EIZO	RX340	10000081	DICOM	3044

RadiNET Pro Web Hosting

✓ Device List: All Device Information in Here

- ✓ Detailed monitor info.
 - ✓ Usage Time
 - ✓ Sensors setting
 - ✓ Calibration target
- ✓ Workstation
 - ✓ PC name / IP address
- ✓ Graphics Board
 - ✓ Name / Driver Version

Item	Value
Asset Number	(undefined)
Usage Time (Daily Average)	-H (-H)
Installed on	2019/11/22
Connection	USB (Connected)
Luminance Sensor	Integrated Front Sensor
Presence Sensor	Yes
Illuminance Sensor	Yes
Size in inches	30
Resolution	3280x2048
Monitor Type	Color (Hardware Calibration)
UDI	-

Item	Value
CAL Switch Mode	DICOM
Calibration Target	DICOM Part 14 GSDf [0.65cd/m²-400.00cd/m²] 7500K
Current Lamb	0.00cd/m²
Baseline Value	L_{max}=400.00cd/m², L_{min}=0.65cd/m², L_{amb}=0.00cd/m²
QC Guideline	Basic QC Primary
Multi-monitor	Enable
User/Comment	(undefined)
Comment	(undefined)
Backlight Meter	Insufficient amount of data
Backlight Status	Unable to confirm backlight status

RadiNET Pro Web Hosting

✓ Smart Management with Group Policy Setting

✓ Provide various common settings to all monitors

- ✓ QC guideline
- ✓ Schedule
- ✓ Calibration setting
- ✓ Registration info.
- ✓ Enable functions
- ✓ Monitor setting

The screenshot displays the 'Group Policy' configuration window. On the left, a tree view shows a hierarchy: 'EIZO Healthcare' containing 'EIZO Test Clinic', 'RSNA2019 Clinic', 'TEST Clinic CA', 'TEST Clinic NY', and 'TEST Clinic TX'. The main area has three tabs: 'QA Settings', 'RadiCS Settings', and 'Monitor Settings'. The 'QA Settings' tab is active, showing sections for 'QC Guideline', 'Schedule', and 'Calibration'. Under 'QC Guideline', there are options for 'Current QC Guidelines' (Basic Mammo QC, Basic QC, Basic QC Primary, Basic QC Secondary) and 'Multi-Monitor Judgment ON'. The 'Schedule' section includes 'Execute Schedule according to local time' and a table of tasks: 'Visual Check' (every 1 days 00:00), 'Consistency Test' (On the 1st every 1 month(s) starting from January 00:00), 'Calibration' (Execute test), and 'Execution timing' (Automatically execute Calibration if monitor failed Luminance check and Grayscale check, January 1st every 1 year(s) starting from 2020 00:00). The 'Calibration' section shows 'On schedule' and a note 'No policy has been applied.'

RadiNET Pro Web Hosting

✓ Smart Management with Group Policy Setting

✓ Flexible schedule setting for each task

- ✓ Daily
- ✓ Weekly
- ✓ Monthly
- ✓ Yearly
- ✓ Date and Time

Policy Settings (Schedule)

Enable schedule function Execute Schedule according to local time

Visual Check every 1 days 00:00

Consistency Test On the 1st every 1 month(s) starting from January 00:00 Execute test

Calibration January 1st every 1 year(s) starting from 2020 00:00

Hands-off Check every 1 days 00:00

Execution timing

On schedule

At logon

< Back Cancel Finish

Execution Pattern

Day Week Month Year

* Interval 1 week

Sunday Monday Tuesday Wednesday

Thursday Friday Saturday

Time 00 : 00

Execution Pattern

Day Week Month Year

* Interval 1 month Start month January

Date 1st

Day of the week First Monday

Time 00 : 00

Execution Pattern

Day Week Month Year

* Interval 1 year Start year 2020

Date January 1st

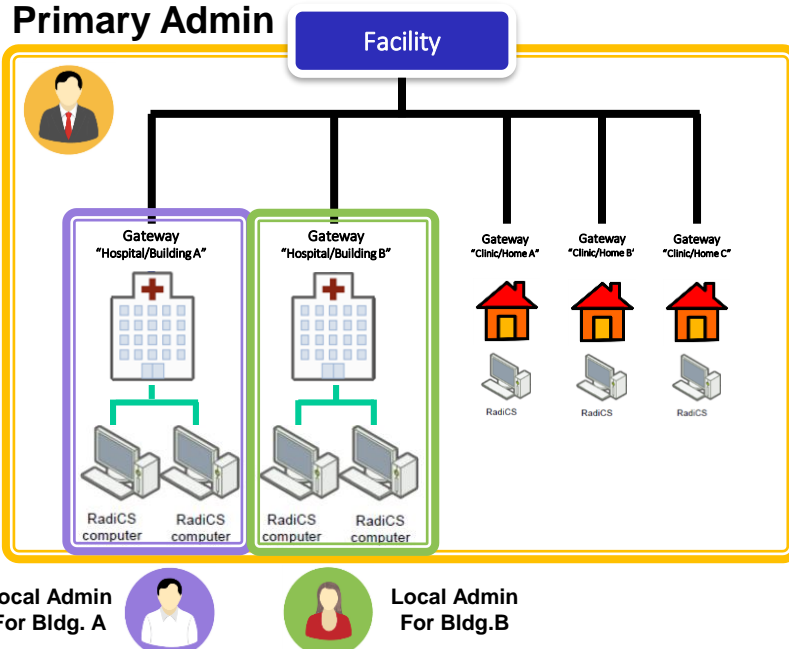
Day of the week January First Monday

Time 00 : 00

RadiNET Pro Web Hosting

✓ Multi-site Management

✓ Support tele-radiography environment



Facility

- Top level (parent) organization such as entire Hospital group.

Gateway

- Child organization, grouped by a physical gateway computer

RadiCS computers

- Workstations where EIZO monitors connected, typically diagnostic workstations

Can set multiple local(Gateway level) administrators

The background is a solid blue color with abstract geometric patterns. There are several thin, light blue lines forming a network of points and connections, resembling a molecular structure or a data network. Additionally, there are several yellow lines: one single line starting from the top center and extending towards the right, and two parallel lines starting from the right side and extending towards the bottom right. A small yellow 'x' mark is located near the top right of the main text area.

Making Each Life Visual