

Upgrade of the USGS TRIGA Control Console

TRTR

September 21, 2010

Tim DeBey

US Geological Survey

U.S. Geological Survey TRIGA Research Reactor

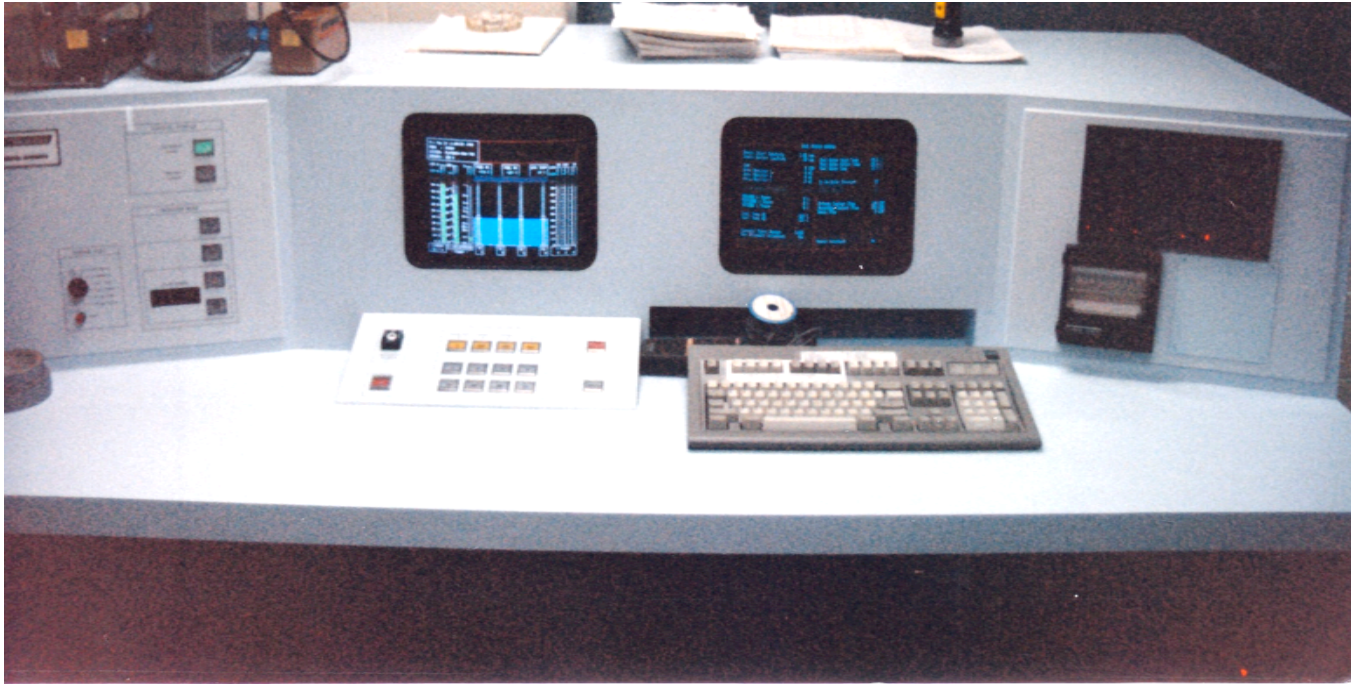
- Located at the Denver Federal Center
- Initial criticality Feb 26, 1969
- TRIGA Mk1 (in-ground pool)
- 1 MW maximum steady state power
- Pulsing capability up to ~1600 MW peak
- ~450,000 sample irradiations performed
- Reactor room is a converted truck garage



USGS Original Control Console - 1969

- Original console was completely analog
- Discrete transistors in circuitry
- Ink pen chart recorded for power display
- Multi-position range switch for linear power
- Lots of wires going from console to reactor
- A robust system; biggest problem was dirty contacts
- Ash trays were a required accessory (should have been built-in)

- Parts for original console became increasingly difficult to acquire
- Ink pen chart recorder became increasingly frustrating to deal with
- New “digital” console was ordered from General Atomics in 1986
- Delivery was scheduled for late 1988



TRIGA "digital" console - 1990

Data
Acquisition
Cabinet



- “Digital” console had analog circuits for all scram channels and scram input circuits
- Display and control functions were done digitally, with an ethernet connection between the console computer and the data acquisition computer
- Amount of wiring from console to reactor was greatly reduced
- Software was written in “ICDOS” (proprietary operating code)

- New console computers had Intel 80286 processors, running at 12 MHz
- Printer was dot matrix, parallel port
- Console acquisition, processing, and display of reactor pulses was vastly improved over original analog system
- Biggest adjustment for operators was that controls and indications did not respond instantaneously like the analog console
- Installation of new console was done as a license amendment; completed in 1991

- We moved from technology that became obsolete in 20 years to technology that became obsolete in 5 years
- Early purchasing of spare parts became critical



Our new console had wonderful new features such as:

- A lot of information was displayed on CRT monitors
- Pulse calculations and power display much far beyond what analog console could do
- Automatic data logging & playback to review operations
- Unplanned scram rate increased dramatically (~50/yr) due to console problems.



"Miss Johnson, would you mind ordering me another computer? And you can cancel that call to tech-support."

- In 1999, the ominous approach of Y2K provided the opportunity to purchase an upgrade of the “digital” console
- The upgrade provided:
 - Guaranteed Y2K compliance
 - New computers (Intel Pentium at 500 MHz)
 - New computer boards
 - New software (written in Qnix)
 - More “robust” system
- The upgrade was completed in 2000 as an approved 50.59 change

Our upgraded console had wonderful new features such as:

- Faster response
- No more hard drive problems
- Unplanned scram rate dropped to ~10/yr due to console problems.

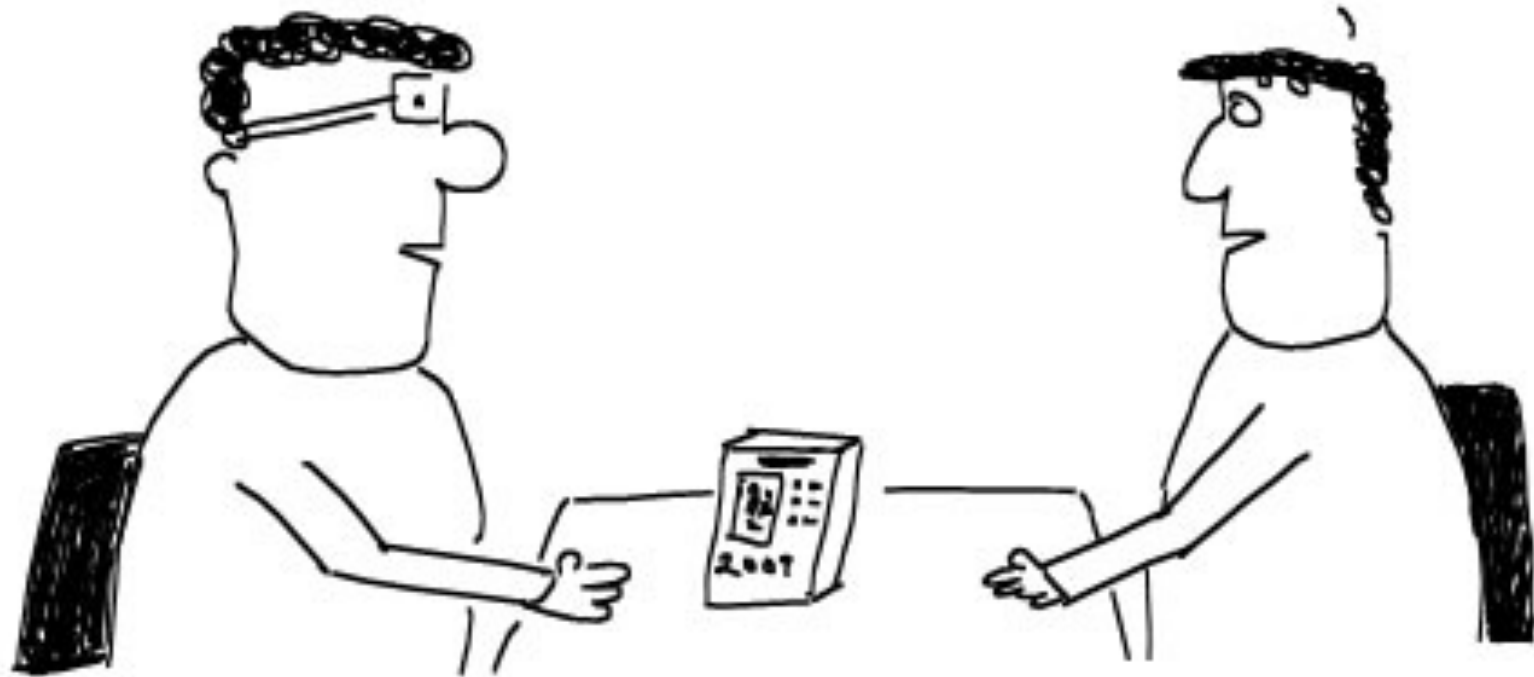
- Obsolescence continued to present problems
 - Parallel port printer was increasingly difficult to maintain/replace
 - Tektronics high resolution monitor is no longer manufactured or supported
 - Computers and plug-in boards are no longer manufactured or supported
 - Computer keyboard & mouse with large, round connector aren't readily available



"Okay your father managed to get a mouse. Now how do we use it?"

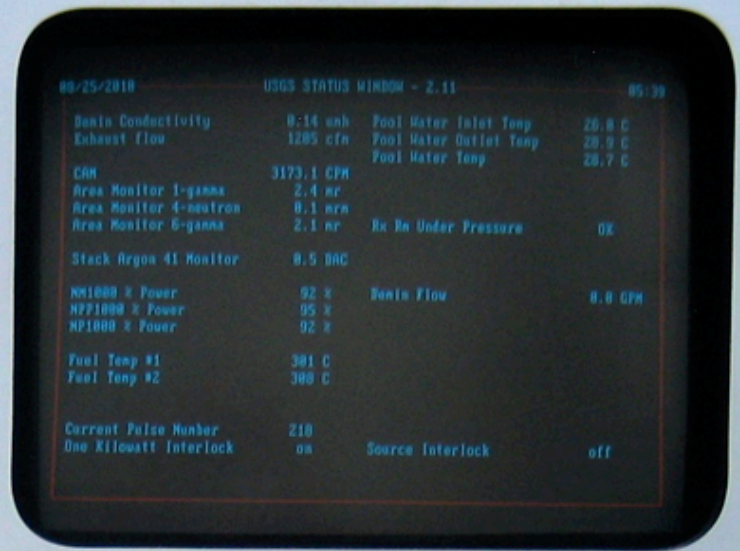
- In 2005, we seized an opportunity to order a second upgrade of the “digital” console
- The upgrade would provide:
 - New computers (Intel Xeon dual core, 2 GHz)
 - USB ports (mouse, keyboard, printer)
 - New computer boards
 - New software (written in Linux)
 - LCD monitors
 - Faster ethernet connection
- The upgrade will be completed this month as an approved 50.59 change

So what does your
2009 version do
that 2008 doesn't?



Well, it doesn't
make you feel
outdated.

- Observations from latest upgrade
 - Physical size of components decreased significantly
 - Specs (capabilities and precision/accuracy) of components increased significantly
 - Increase in computing power is far beyond what is needed
 - Larger monitors with higher resolutions are appreciated by all operators

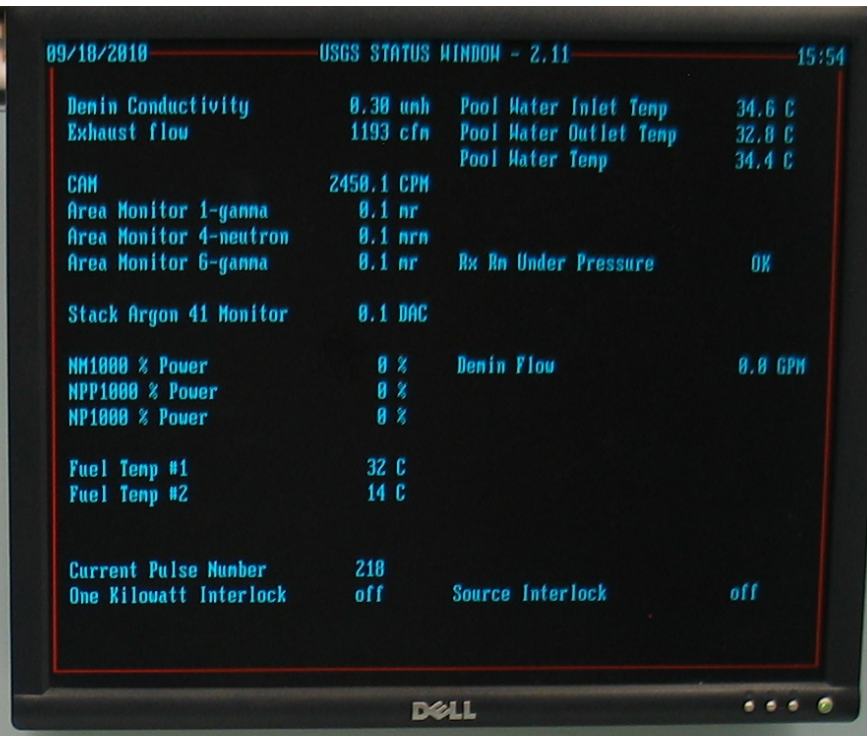


ROD POSITION CONTROL

TRANSIENT SHIM 1 SHIM 2 REG

Control panel with buttons and a red emergency stop button.

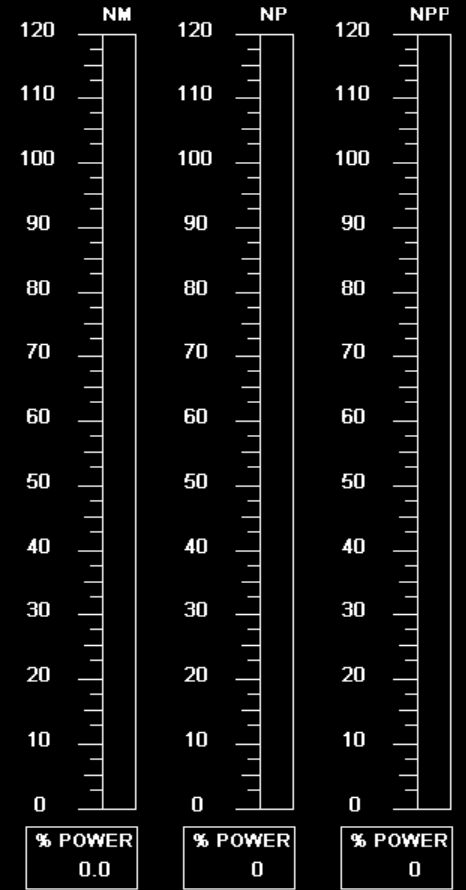
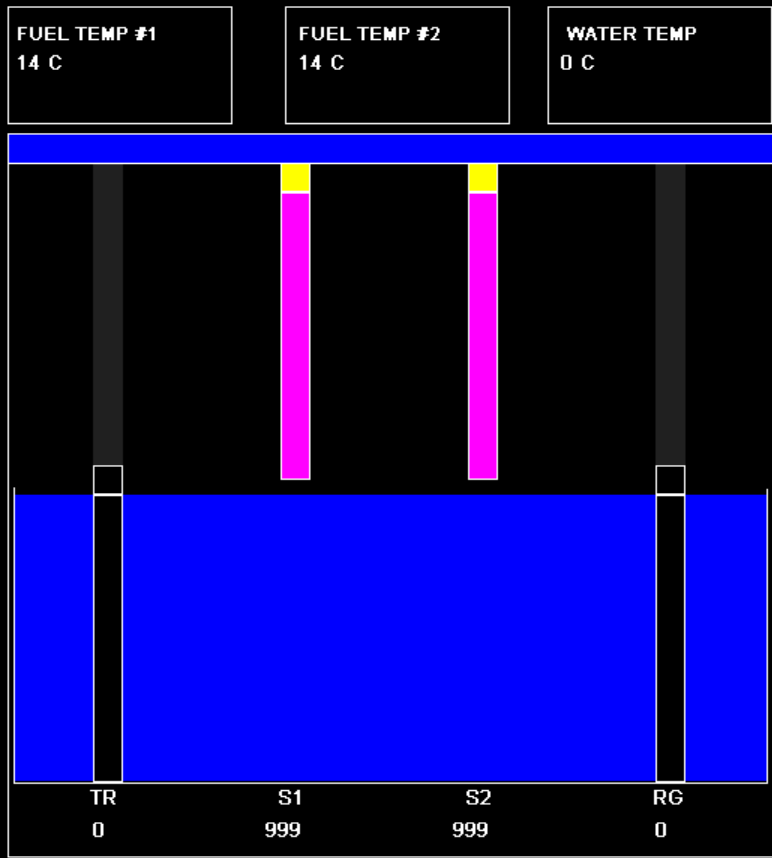
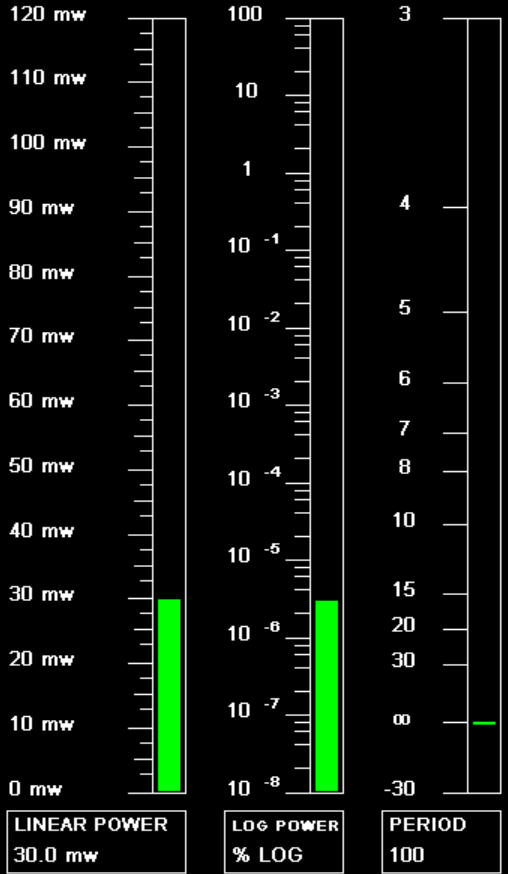




Sep 16, 2010 05:37:11
MODE : SCRAM
SYSTEM: REALTIME
DEMAND POWER 0.0 mW

SCRAM

USGS Triga System
#0: (no operator)
0d 00:01



Transient	Shim 1	Shim 2	Reg	
AIR	MAGNET	MAGNET	MAGNET	SCRAM
UP	UP	UP	UP	
DOWN	DOWN	DOWN	DOWN	ACK

FIRE

STATUS

NM1000 Power = 2.77e-2 Watts
NP % Power = 106.0%
NPP % Power = 106.0%
NM1000 Log %Power = 106.0%
Period = 4.50
Primary Flow = 0.0 liters/sec

SCRAMS

Fuel Temp #1

Fuel Temp #2

Fuel Temp #3

NPP HV Low

NPP Percent High

NP HV Low

NP Percent High

External SCRAM #1

External SCRAM #2

Low Pool Level

Watchdog SCRAM

System SCRAM

WARNINGS

NM1000 HV Trip

NM1000 1KW Trip

NM1000 Low Source T

NM1000 Period High

NM1000 % Power

RWP

NP % Power

NPP % Power

Mag Pwr Low Grded

Inlet Temp

Outlet Temp

Pool Temp

Neg Air Press

Rad Area #1

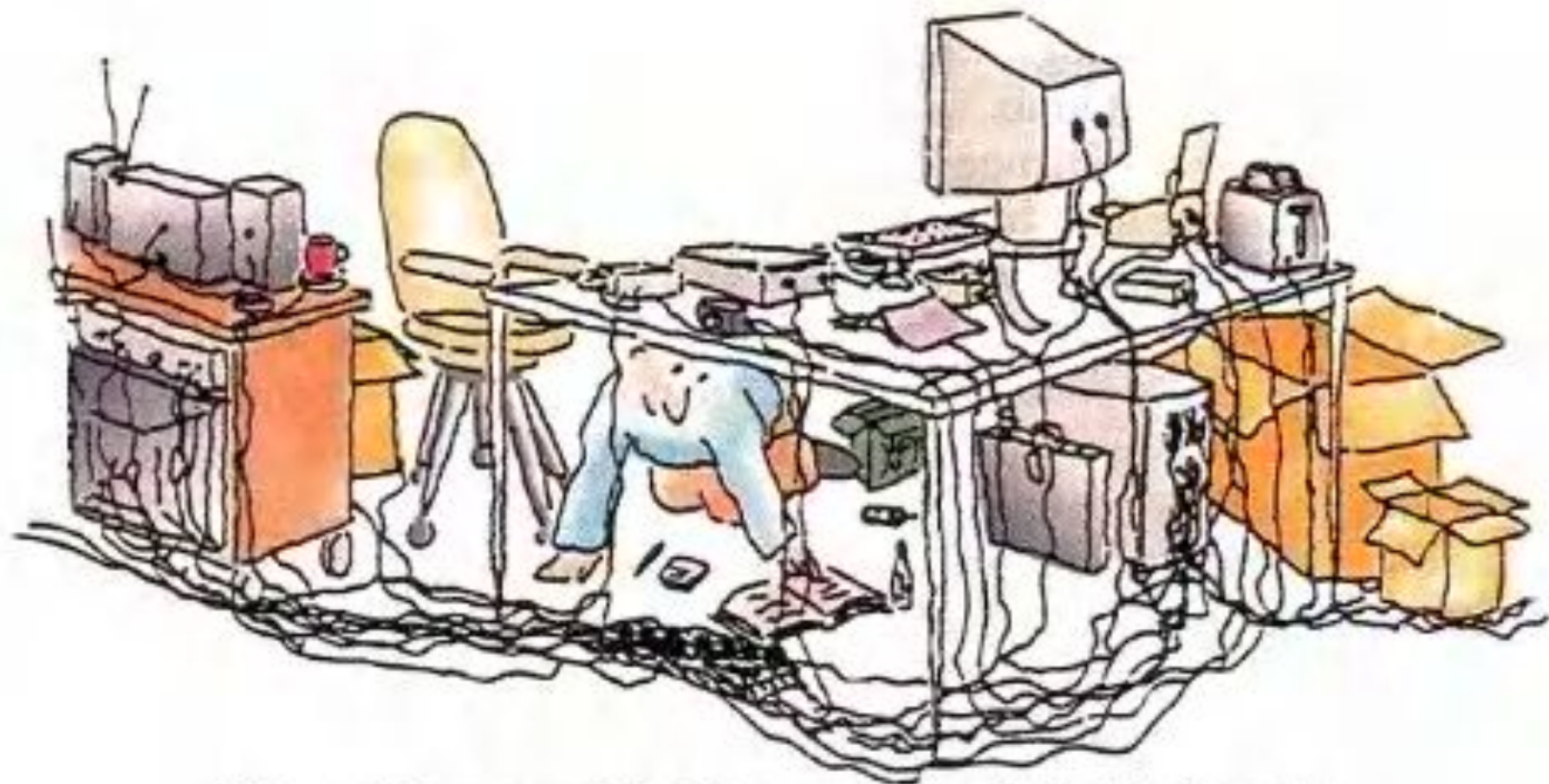
Rad Area #2

Rad Area #3

Rad Area #4

Our recently upgraded console has wonderful new features such as:

- Faster response
- Wiring “clutter” is reduced
- New monitors have larger display areas and present more information at one time – no paging through screens
- USB ports exist and are usable
- Hardware troubleshooting is much easier
- Unplanned scram rate ???



“Now, if you can find the power switch, flip it on.”

Key points:

The feel and function of the console is the same as it was when originally installed in 1991.

Safety system is still analog; scrams are still hard-wired.

Speed of response to inputs has been improved.

Troubleshooting has been made easier.

New hardware accesses new media types: USB and DVDs vs floppy disks and CDs

Upgrade is being installed in a “reversible” manner.

Questions?