MIT Research Reactor

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MIT Reactor Protection System using DWK250 Channels and PLC Logic Circuit

Phase 0 Review Public Meeting with NRC
October 12, 2012

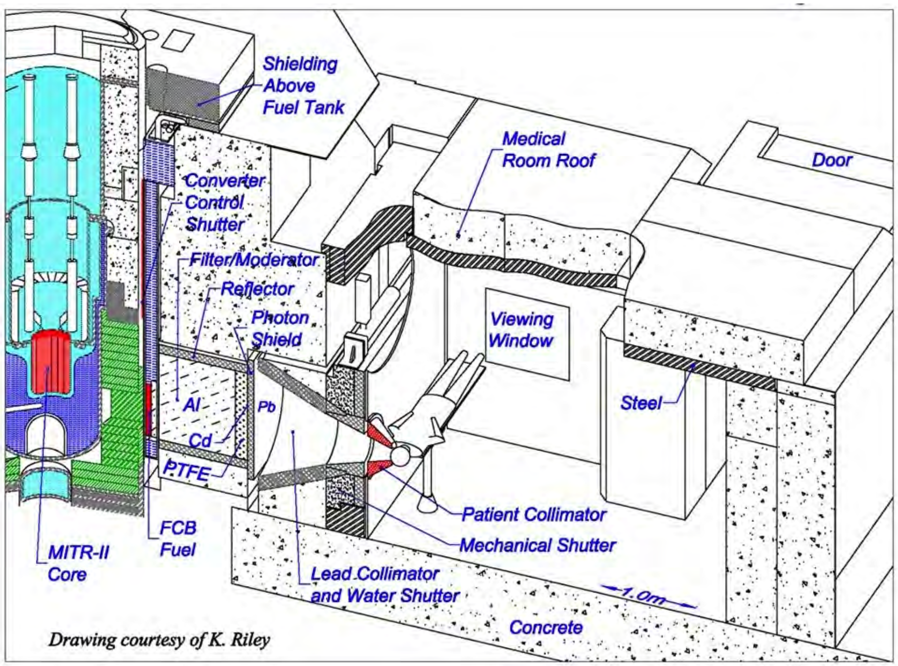
Discussion Topics

- Overview of MIT Research Reactor
- Existing MITR Nuclear Instrumentation & Control
- Upgrading to Digital Nuclear Instrumentation
- Description of DWK250 Channel
- Status Update on Use of PLC Logic Circuit
- Schedule for License Amendment Request
- Documentation & License Amendment Content
- Questions & Comments

Overview of MIT Research Reactor (i)

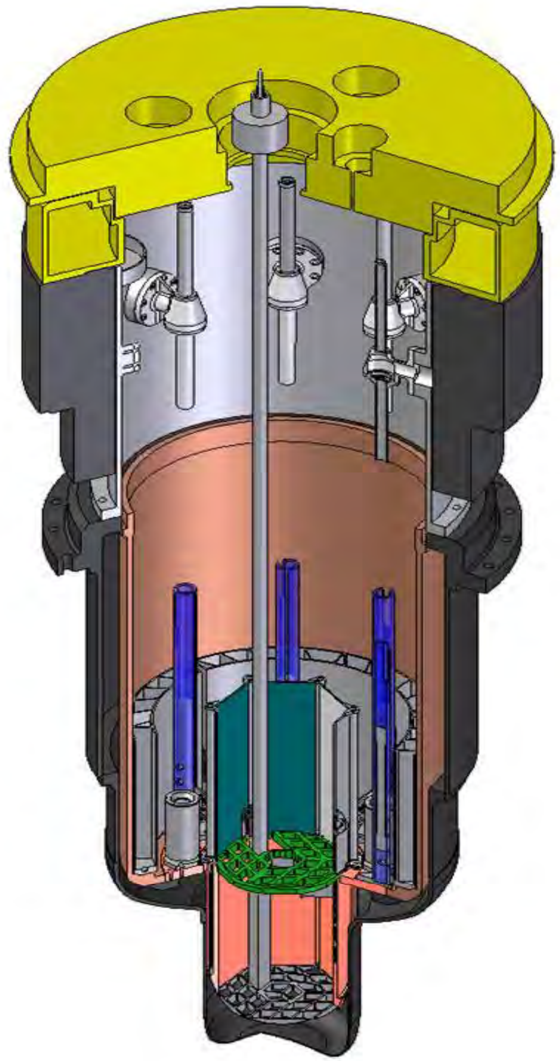
- Constructed in 1958
- Upgraded in 1975
- Capable of operating 24/7 at up to 6 MW thermal power, ~65% capacity factor
- Tank-type, light water to cool and moderate
- Two-loop cooling system, modern cooling tower
- Uses heavy water D_2O for neutron reflection
- Graphite outer reflector

Overview of MIT Research Reactor (ii)



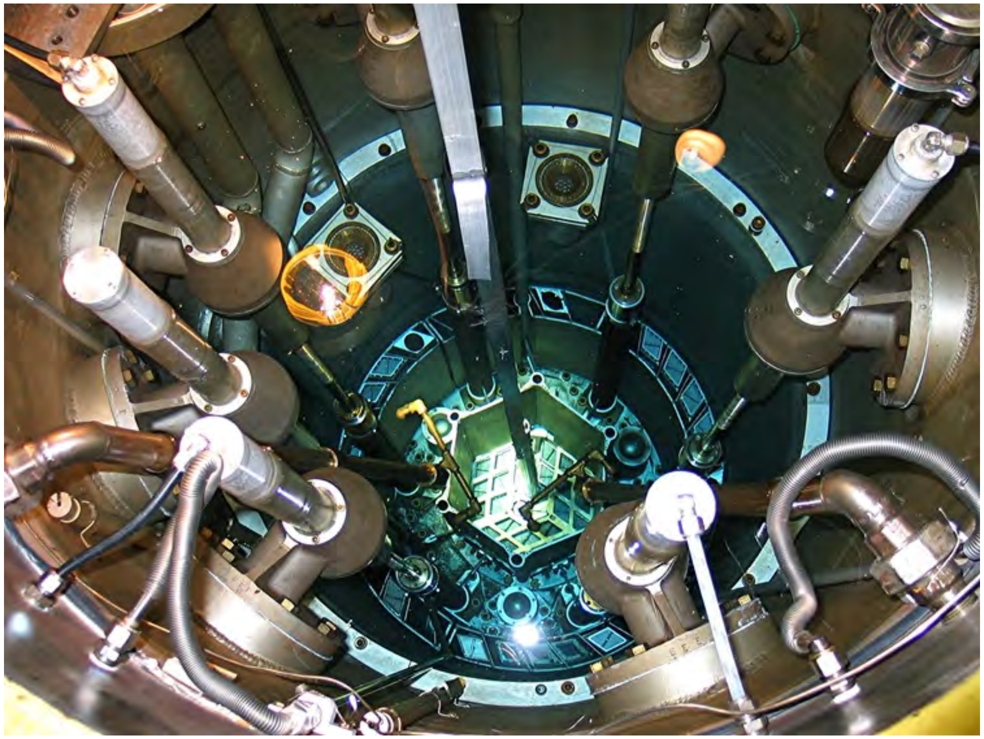
- U-235 fuel
- Primary loop circulates at ~2000 gpm
- Secondary loop circulates at ~1800 gpm
- Six shim blades and one regulating rod
- Safety channels: three on power level, three on reactor period
- Three more channels, displaying megawatts

MIT Reactor In-Core Experiment Capability



- Capable of performing up to three in-core experiments simultaneously for the highest neutron fluxes
- In-core thermal neutron flux is $3x10^{13}$ #/cm^2-s, and fast flux is $1x10^{14}$ #/cm^2-s; similar to full-size commercial light-water power reactors
- U.S. NRC authorized in-core fuel irradiations of up to 100 grams of fissile material
- Advanced materials and fuel research

MIT Reactor Experiment Capability

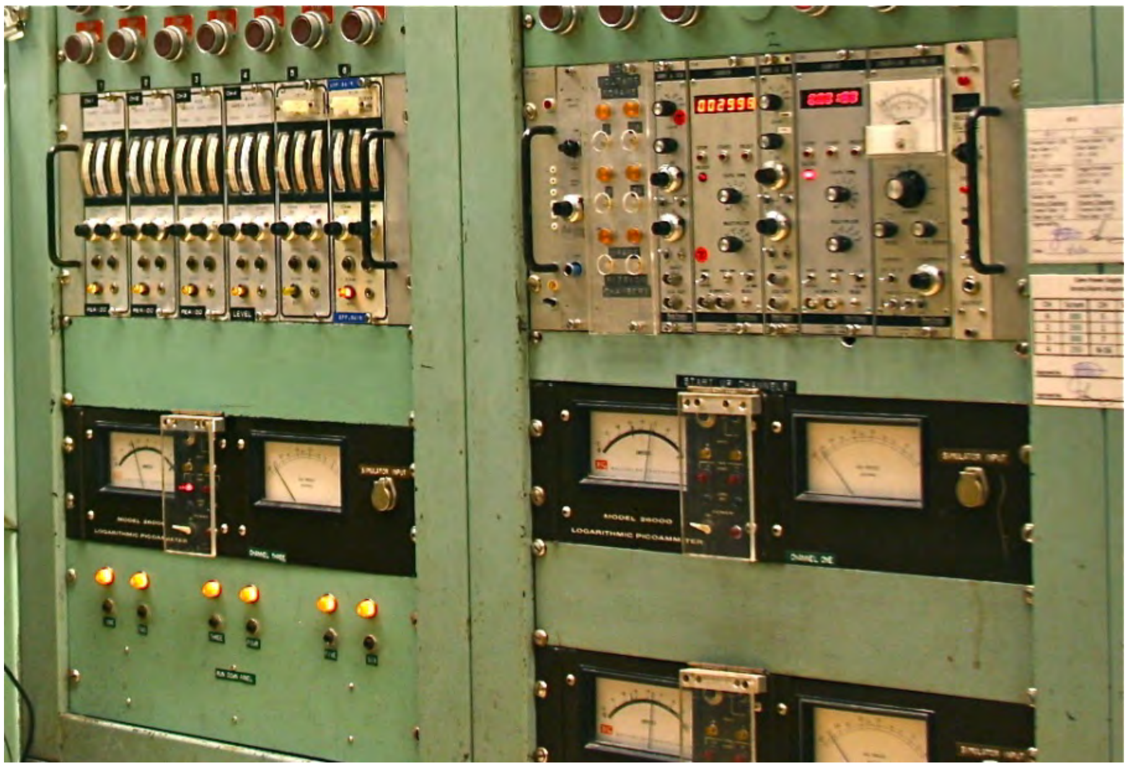


- In-Core Sample Irradiation Facility (ICSA) provides fast neutron flux of up to $1x10^{14}$ #/cm^2-s
- Other facilities provide thermal flux up to $5x10^{13}$ #/cm^2-s for NAA and isotope activation

Reactor Operator Training

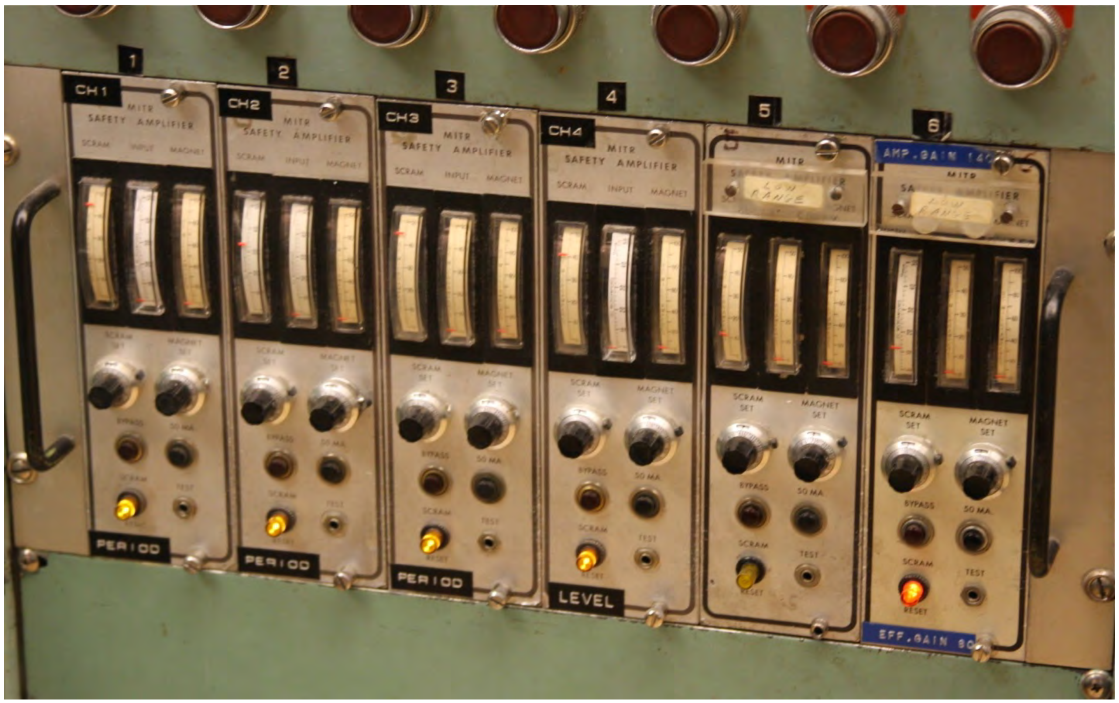
Primary Heat Exchanger & Major Coolant Piping – New in 2010

Existing MITR Nuclear I&C – since 1975



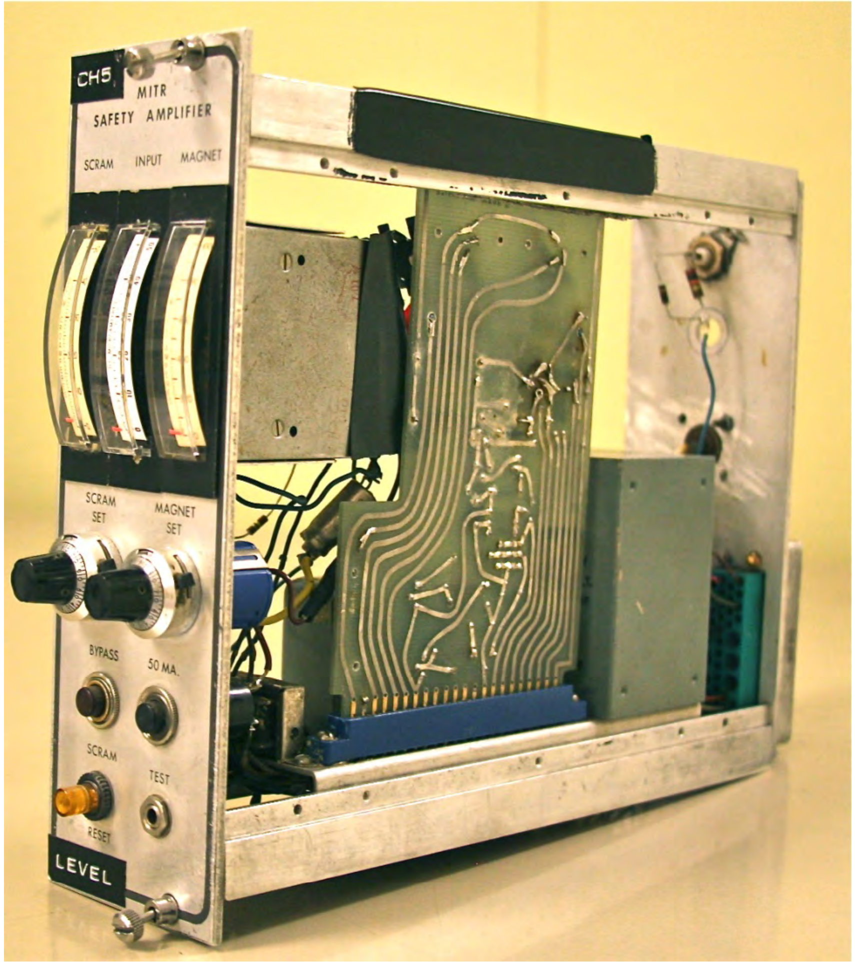
- Channels #1 through #6
- Ch. #1 - 3 for
  short reactor period scram
- Ch. #4 - 6 for
  high reactor power scram
- Ch. #1 - 3 Keithley model 26000 meters measure period
- Ch. #1 & #2 operate on fission chambers for source range <u>or</u> on ion chambers for power range
- Ch. #5 & #6 can switch to low-range amplifiers for <100 kW operation

Existing MITR Nuclear I&C – since 1975



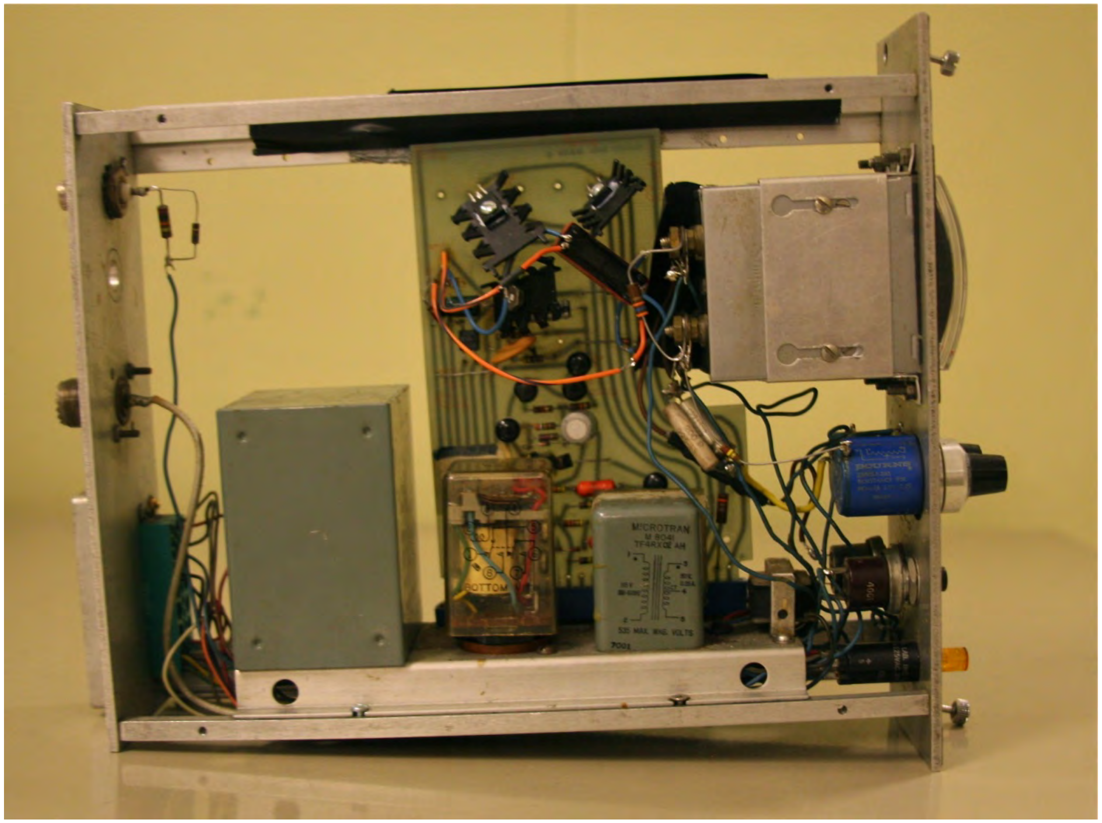
- Custom built by MIT-NRL
- Analog components subject to aging
- No more spare parts
- Fixing one part breaks two more
- 120-volt operation
- Set-points drift, particularly with ambient temperature and component heat-up over time
- Channel calibrations and scram checks only with the reactor shut down

Analog Nuclear Instrumentation Channel



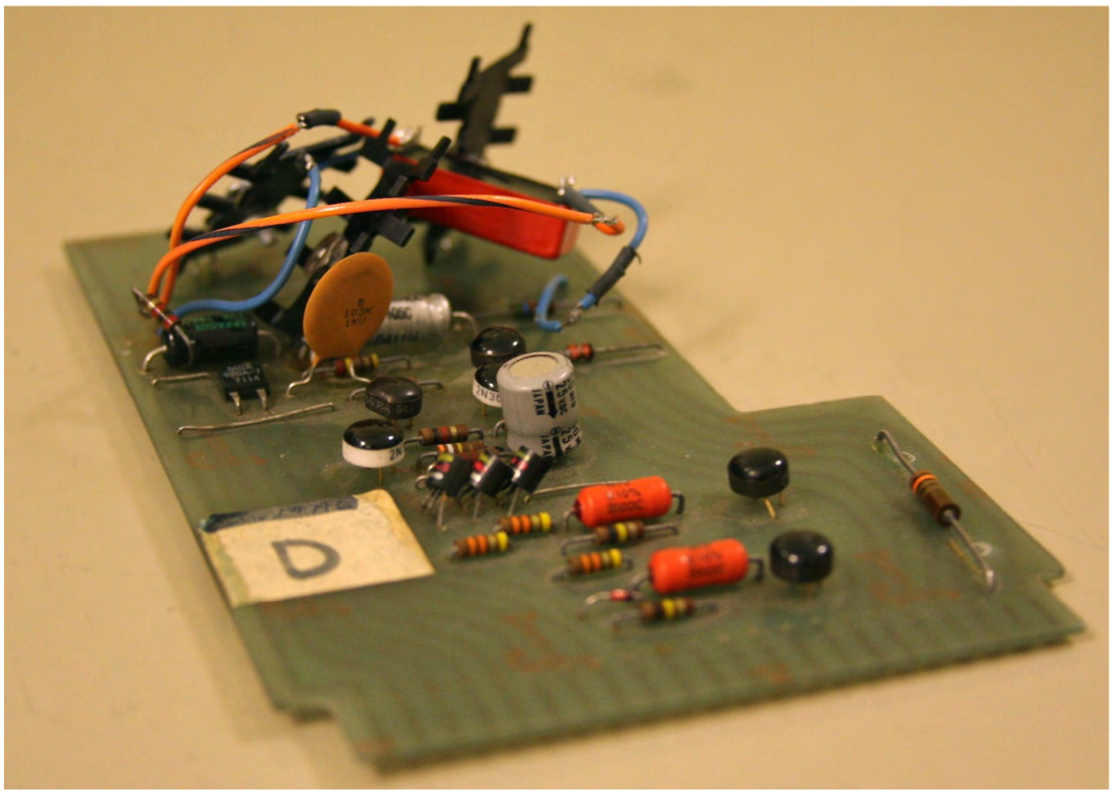
- Fully analog safety amplifier for each channel
- Curved meter faces
- Non-adjustable zeroes
- Scram test signal doesn't follow the path of the input signal from the detector
- Meter response imperceptible for high-range amplifiers at low power
- Can't tell if your detector is unplugged!

Analog Nuclear Instrumentation Channel



- Ch. #5 & #6 amplifier NIM bins (rear pin receptors) began to fail frequently from repeated connection and disconnection
- Ch. #5 & #6 require circuit board switching between low–range amplifier and full power amplifier; this accelerated failure of the circuit board
- Circuit connection strips on installation-edge of board physically wearing out
- Circuit paths fading

Analog Nuclear Instrumentation Channel



- Circuit board layout is different for every amplifier, to compensate for different detector characteristics
- Components and wiring susceptible to noise interference, resulting in frequent spurious trips
- Solder joint corrosion
- Large heat sinks are a must for heat-producing transistors; active local fan cooling was also required, which added vibration

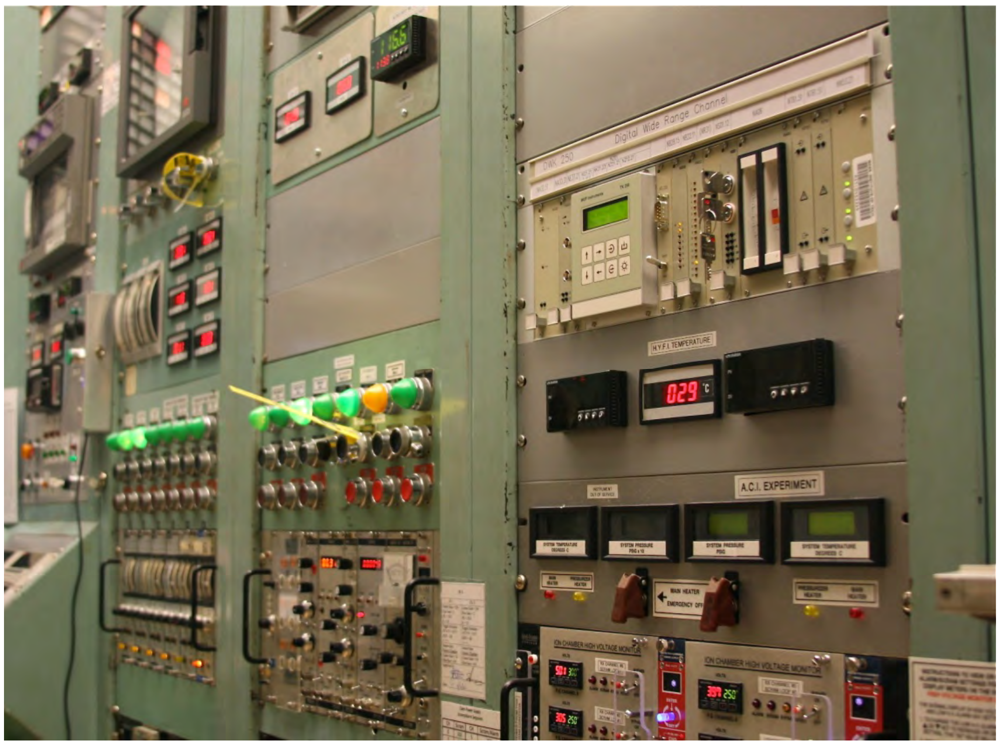
One of Four New
Mirion DWK 250 Channels for MITR

- Each channel provides short reactor period scram & high reactor power scram
- Each channel utilizes one fission chamber for wide-range power operation
- Reactor power and period calibration and scram checks can be done with the reactor operating
- Test signal travels along the detector signal path starting from the fission chamber pre-amplifier

One of Four New
Mirion DWK 250 Channels for MITR

- Each DWK 250 monitor incorporates three different microprocessor modules for signal processing
- Each microprocessor executes its function as set by the firmware permanently programmed into its non-volatile memory EPROMs.
- Execution of firmware is confirmed by continual checksum comparison
- Microprocessors and firmware have field-proven reliable for >25 years in European nuclear industry

One of Four New
Mirion DWK 250 Channels for MITR



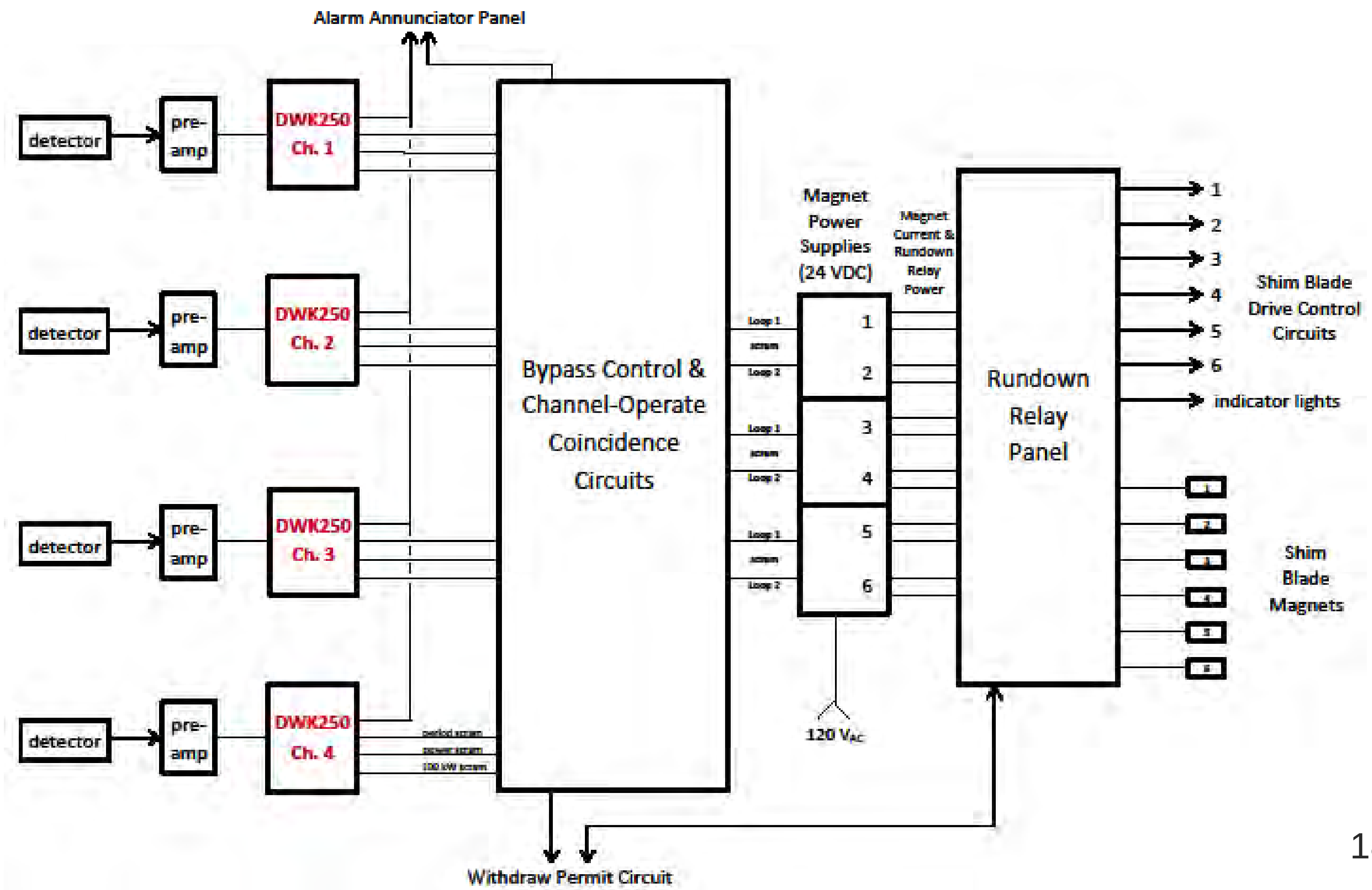
- The microprocessors handle pulse signals and also perform “Campbelling”, allowing wide-range indication
- Trip set-points do not drift
- Detector voltage and internal operating voltages monitored for compliance with adjustable tolerances
- Continuous Op-code handshaking between the DWK’s microprocessors as an active check of functionality

One of Four New Mirion DWK 250 Channels for MITR

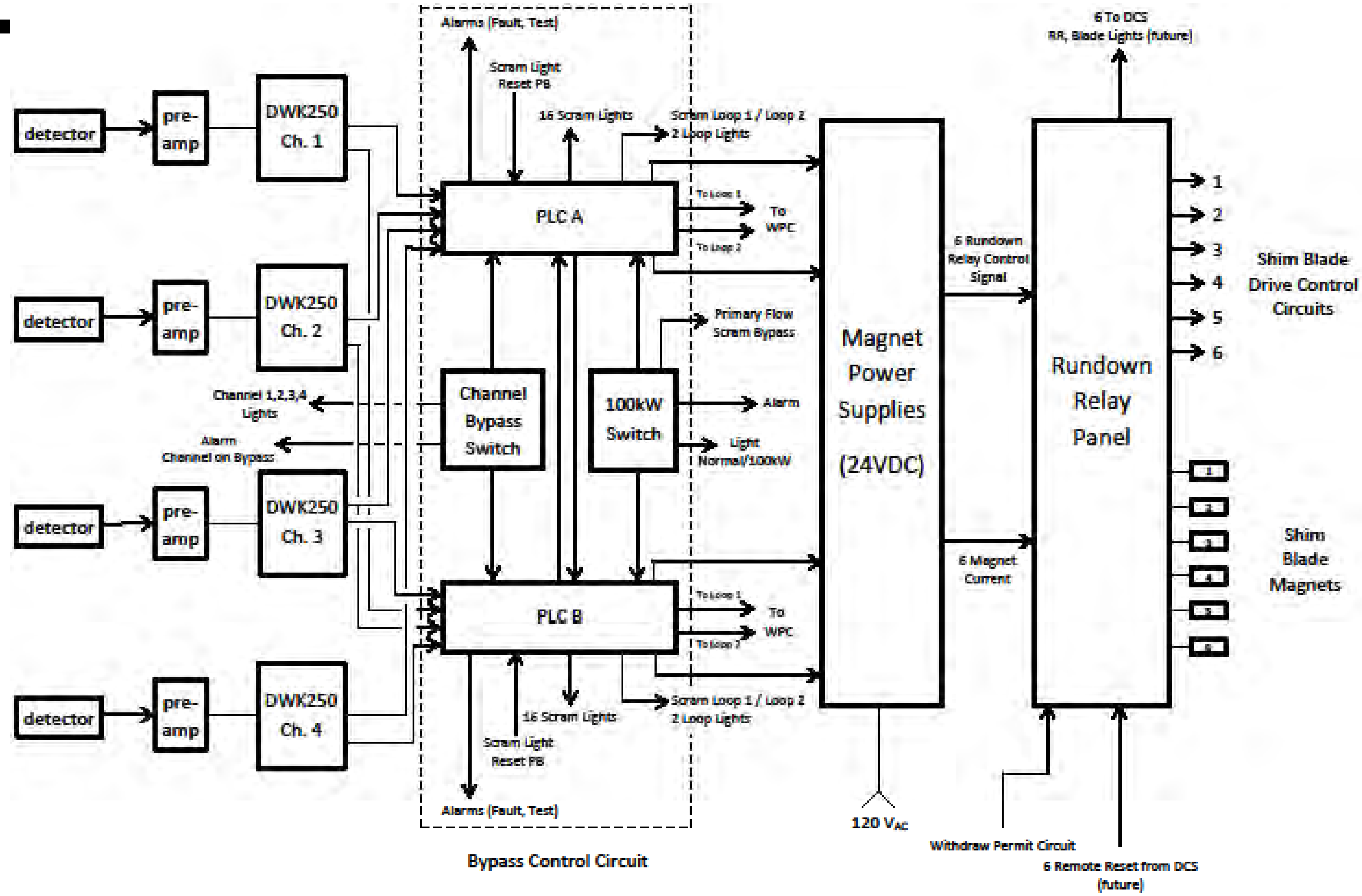
- Eight binary (relay) outputs – DWK uses two for internal fault indication; MITR uses two for scram circuit

- Two analog outputs
- One digital output
- MITR will use for display and recording

MIT Reactor Protection System



MIT Reactor Protection System using PLCs in the Coincidence Circuit



Block Diagram of MIT Reactor Protection System (Dual-PLC Concept)

DWK 250 Quality Standards

- DWKs, their firmware and their pre-amps designed and manufactured in Germany
- Qualified by TUV per German nuclear regulatory KTA guidelines 3501, 3502, 3505, 3507, and 1401
- Compliance with international standard IEC 61226 for safety equipment Category A
- Equivalent to IEEE 323 Classification 1E equipment for nuclear power stations, and to IEEE 344 Classification 1E equipment with regards to seismic qualification

Description of DWK250 Channels

- See separate presentation material from Mirion Technologies:
  - Technical Description
  - Qualification and Certification

DWK 250 Wide Range Neutron Flux Measurement Channel

- 1 Detector for Start-up/Intermediate/Power Range
- Source Range Pulse Processing
- Campbell (RMS) Processing for Intermediate Range
- Combined pulses/RMS signal provides Wide-range output

NFMS 250

Mirion Technologies
(MGPI H&B) GmbH, Munich

MITR DWK 250

Digital Wide Range Channel

(from the ProTK^{TM} family of signal processors)

proTK™ Signal Processing Neutron Flux Monitoring System

- **MAJOR ATTRIBUTES**
  - **Modular construction**
  - **Versatile applications**
  - **Robust and reliable**
  - **Proven by operational experience**

The proTK™ Neutron Flux Monitoring System combines long term experience in design and manufacturing of both detectors and signal processing electronics. These products are strictly oriented to the highest level of safety relevance and reliability which are qualified by several type tests and proven by excellent operational experience. The proTK™ covers requirements for measuring equipment used for the reactor protection system according to IEC 61226 cat A.

- **APPLICATIONS**
  - **Operational process monitoring**
  - **Measurement & monitoring of neutron flux & the rate of change, spanning start-up, intermediate, and power operation**

proTK™ Signal Processing Neutron Flux Monitoring System

Digital Neutron Flux Channels

DAK 250	**Source range and intermediate range monitoring** With pulse processing or DC signal processing, reactimeter optional also used e.g. for steam generator leakage monitoring (N16)
For MITR: DWK 250	**Wide range monitoring** With combined pulse processing and Campbell signal processing using in-core& ex-core fission chambers
DGK 250	**Power range monitoring** For the PWR with 1 or 2 signal paths for neutron ionization chambers
DLK 250	**Flux distribution monitoring** For 3 or 6 SPN detectors with background compensation, calibration and noise reduction
DSK 250/ DMK 250	**Local & average power range monitoring** For the BWR with average flux and flow related flux, including stability monitoring

proTK™ Signal Processing Neutron Flux Monitoring System

Features

- Modular system w/separate microprocessor for the safety signal path
- Cycle time of signal processing starting with 5 ms
- Low heat C-MOS technology
- Software fixed in EPROM, efficient self-monitoring
- Remote signal generators & signal simulation
- Qualified according to KTA 3501/3505, DIN V VDE 0801
- Dedicated analog & binary output signals
- Three analog outputs (linear or logarithmic)
- Up to 16 adjustable alarm set-points
- Remote test generators for testing w/o external equipment
- Digital parameters, lockable & non-volatile
- Full testing & data exchange via serial data interface
- Continuous functional self-checks e.g. program flow
- Certified by TÜV according to KTA 3501/3505 (IEC 61226 Cat. A)

✓ *Simple & clear*

✓ *Fast*

✓ *Safe*

✓ *Reliable*

✓ *Testable*

✓ *Type-tested*

proTK^{TM} Neutron Flux System

- ✓ ***Flexibility***
- ✓ ***Sensitivity***
- ✓ ***Integrity***
- ✓ ***Quality***
- ✓ ***Reliability***

MITR CHANNEL:

WIDE RANGE

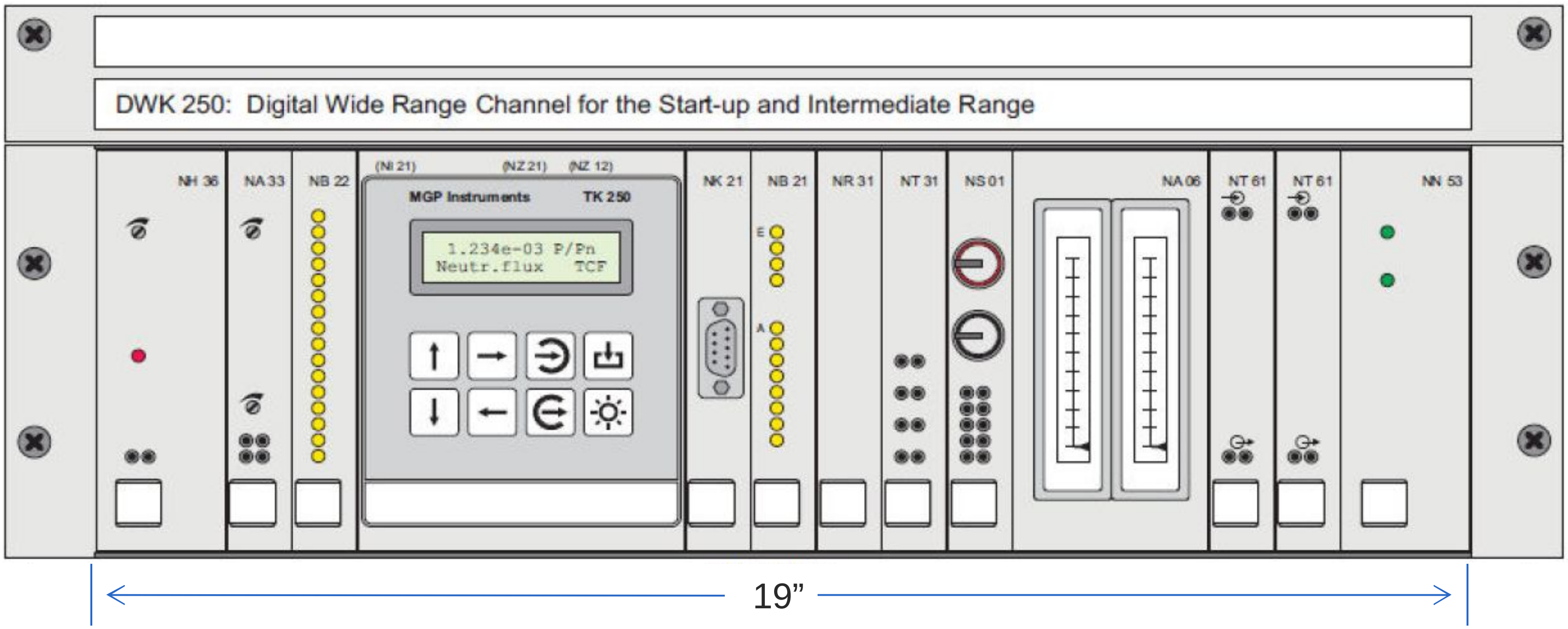
DETECTOR:

EX-CORE, AC MODE, WIDE-RANGE FISSION CHAMBER

SIGNAL PROCESSOR:

DWK 250

DWK 250 Digital Wide Range Channel Main Electronic Rack

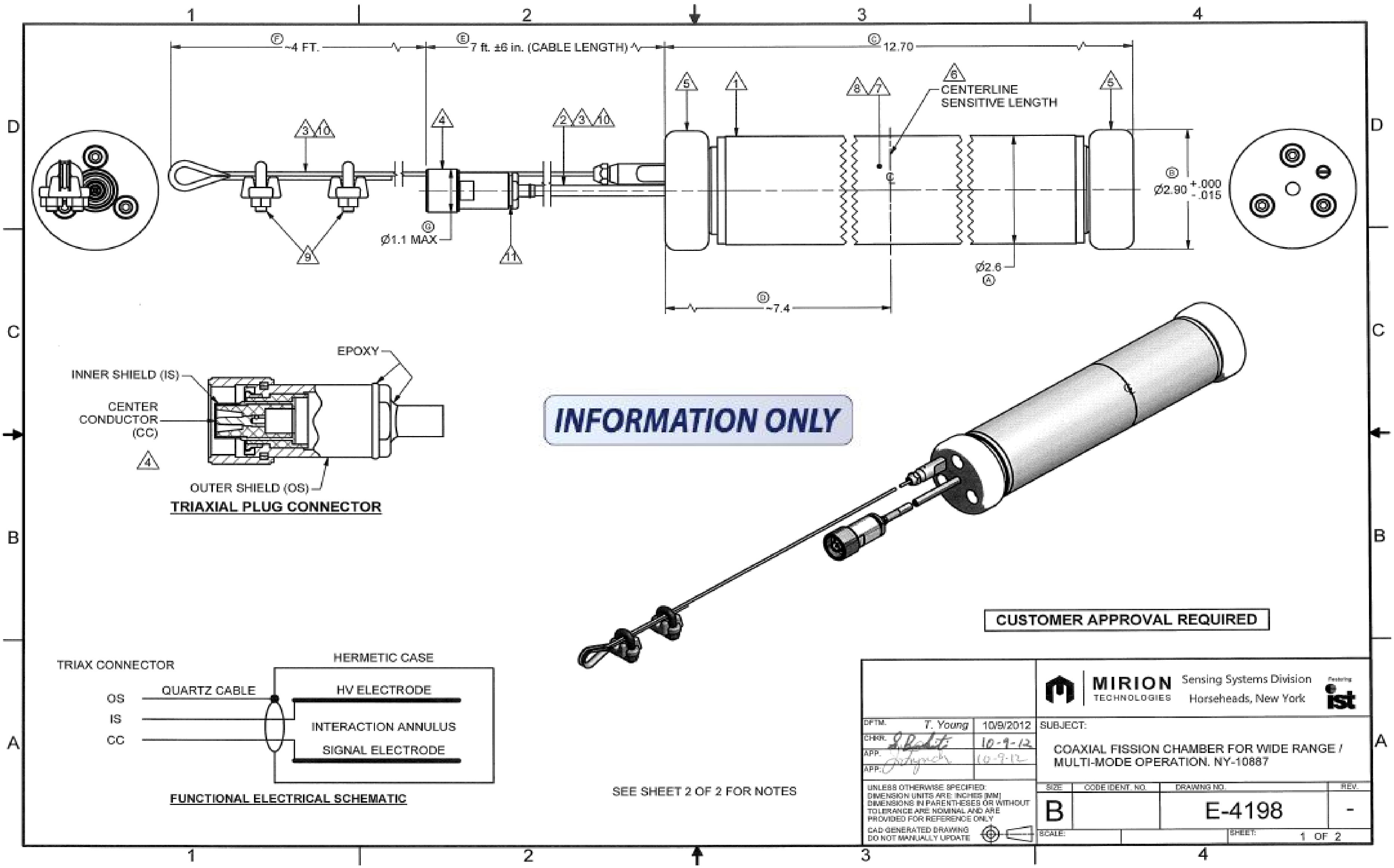


Processes a combination of pulse and Campbell (RMS) signals from in-core (BWR) or ex-core (PWR & MITR) fission chambers to produce pulse, intermediate, and wide-range neutron flux and reactor period signals.

Wide Range Preamplifier TKV 23

- Preamplifier for fission chambers
- Pulse output for start-up range
- Alternate current output for intermediate & Power range
- Signal for high voltage monitoring
- **75Ω** line driver for long cable lengths
- Stable HF- proofed brass housing

Wide-Range Fission Chamber for DWK 250 - slide 1 of 2



Wide-Range Fission Chamber for DWK 250 - slide 2 of 2

Notes:

1. Aluminum chamber housing
2. Nickel jacketed, low noise quartz cable:
   Mechanical:
   Nickel jacket diameter: Ø.260 in.
   Fiberglass insulating tape: Ø.370 in.

   Minimum bend radius:
   Multiple bends ≥ 6 inch
   Permanent bends ≥ 3 inch
   Note that the cable is constructed with thin walled tubing and all bends must be smooth.

   Electrical:
   Characteristic impedance: 75 ohms
3. All cables covered with fiberglass insulating tape or sleeving.
   Wire rope electrically isolated from fission chamber and integral quartz cable.
4. Chamber cable terminated with a triaxial plug interface connector equivelant to Amphenol 53175 with 7/8-20 mating threads. Loose Amphenol 52975 mating triaxial jack connector included for customer termination of their organic field cable.
5. Ceramic insulators provide electrical insulation from instrument well.
   Cable end ceramic is not field removable / replaceable.
6. Centerline of ~ 3 inch sensitive volume length scribed on case.
7. Neutron conversion material: HEU, > 93%wt U-235. U-235 content = 0.2g max.
   Chamber gas is $Ar\text{-}N_2$ at 76 cm Hg
8. Operating Temperature: 250° F, maximum
   External pressure: 180 psi, maximum
   Environment: Surrounding atmosphere to be dry and non- corrosive.
   Operation voltage: 800 Vdc nominal, 1000 Vdc maximum (see note 13)
9. Wire rope length is adjustable by adjusting clamps.
10. Max. working load: 189 lbs.
    Do not lift using chamber's quartz cable
11. Epoxy seal
12. Target Neutron Flux Range: 7×10^{10} to 10 nv using wide range (multi-mode signal processing [e.g. Counting, MSV Campbelling], DC).
13. High neutron flux operation and proper operating voltage will be validated by reviewing in-situ chamber saturation characteristic at full reactor power. Operational characteristics will be evaluated with consideration given to over power conditions (i.e. margin).
14. 1% Neutron Sensitivity Loss: 1.6×10^{19} nvt (based solely on neutron / charge particle conversion material effective cross-section of 614 Barns).

INFORMATION ONLY

CUSTOMER APPROVAL REQUIRED

MIRION TECHNOLOGIES — Sensing Systems Division, Horseheads, New York — featuring ist

DFTM. T. Young	10/9/2012	SUBJECT: COAXIAL FISSION CHAMBER FOR WIDE RANGE / MULTI-MODE OPERATION. NY-10887
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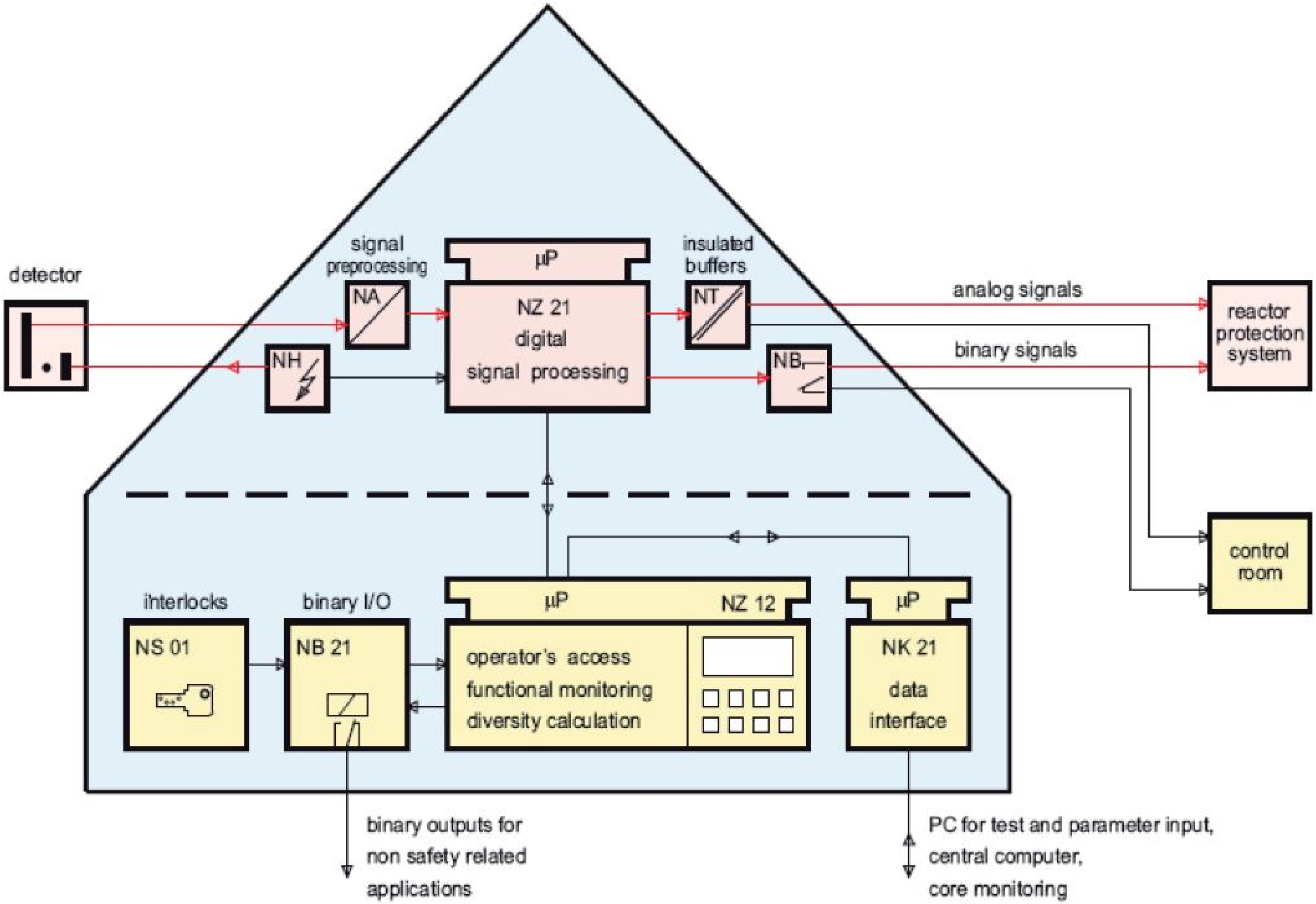
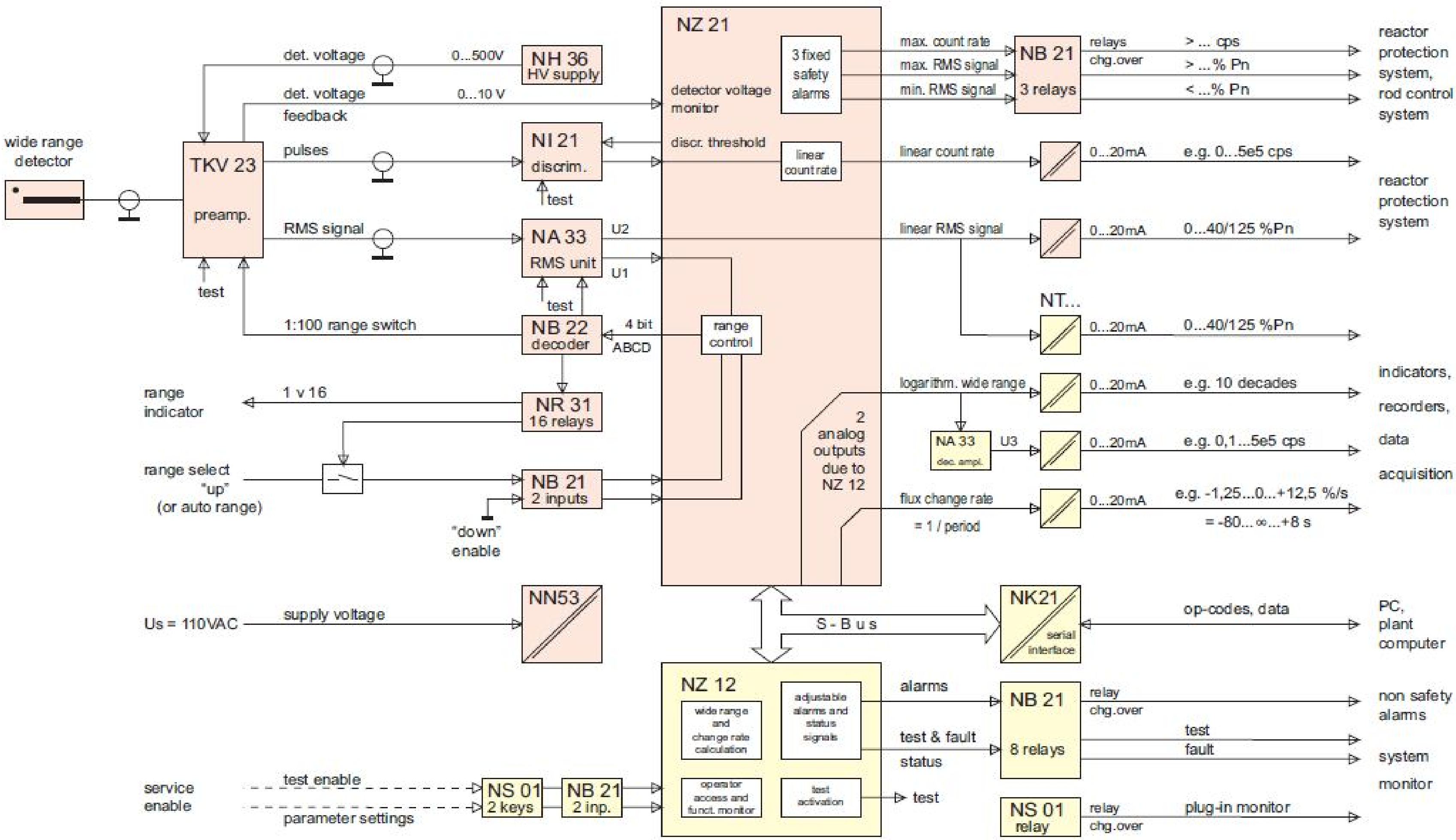
Signal Processing

- **Digital neutron flux monitoring channel DWK 250 is characterized by:**
  - **Efficient functions**
  - **Useful procedures for periodic testing**
  - **Comfortable operators menu structure**
  - **Rugged operational behavior**
  - **Hardware & software are arranged in modules**
  - **Internal multiprocessor structure offers the flexibility of reducing the region of highest safety relevance to a small, separated part within the channel**

Architecture



DWK 250 Functional Diagram



Clear & Simple Design

- **The functions for the safety signal path are concentrated on the independent I/O-micro-processor board NZ 21:**
  - o **The software is purely sequential and deterministic**
  - o **The software operates cyclic in a fixed time grid, e.g. 5 ms**
  - o **Therefore, the response time is predictable**
  - o **There is no operating system**
  - o **The volume of the software is as small as 3 kByte**
  - o **All other functions e.g. operator’s access are allocated on the “main processor board” NZ 12 and both processor boards (NZ 12 and NZ 21) perform self monitoring functions.**
- **Re-use of type-tested and proven software modules**
- **The target: zero-fault software**
  - o **Designed and developed by well-trained engineers**
  - o **Verified and Validated via type test by independent experts (TÜV)**
  - o **Field-proven by long-term operational experience**

Software Credibility

- Measures against CCF of the software
  - Additional to the simple and clear design there is:
    - No use of interrupts on NZ 21, only 1 interrupt on NZ 12
    - No use of real time clock or calendar
    - NZ 12 has no direct access to NZ 21 and its
      - ✓ Program sequence
      - ✓ Data or parameter memory
    - The access to DWK 250 parameters & test-procedures is hardware locked by key switches
    - A variety of self monitoring devices, some of them complementary between NZ 12 and NZ 21

Self-checks & Tests

- **Different tools make periodic testing efficient and easy:**
  - **Test generators in both the pre-amps and input-boards of the channel:**
    - ✓ **Activated remotely without manipulation in the wiring**
    - ✓ **Insert a reference signal to the input of the electronic channel**
  - **The tool “simulation” enables users to:**
    - ✓ **Insert arbitrary numbers at defined points of the signal path**
    - ✓ **Generate all desired output values for analog signals or alarms**
  - **In test mode, binary outputs (relays) may be activated or deactivated**
  - **All testing tools are locked by key-switch and generate a flag signal**
  - **The basic procedure for periodic testing**
    - ✓ **Is described in the user manual**
- **A variety of items is used to detect faults of hardware and software, e.g. monitoring of internal voltage, arithmetic, time schedule, micro-processors, transfer of data, and program memory.**
- **Additionally the NZ 12 is monitored by a watch dog.**

Operator Access

- The access to parameters and testing is locked by 2 key switches
  - o Without key: parameters may be displayed, but not modified
- A parameter protocol may be generated on a PC via serial interface using purely read-only instructions
- The variety of functions and parameters is limited by "configuration" according to customer/project requirements:
  - o Delete (enable and hide) unused functions
  - o Establish "fixed parameters", e.g. scalings or trip thresholds
  - o Use of modified text tables, e.g. language version
  - o Configuration is done by Mirion Technologies
  - o Configuration data are stored in EPROM

Type Testing

- The type test of hardware was performed according to KTA 3505
  - Theoretical and practical tests observed and checked by TÜV
  - Test results transferable to IEEE 323 and IEC 60780
  - Operational history data for all boards available
- Software type test also was performed by independent experts:
  - DPK 251 and DSK 250 by ISEB-TÜV-Rheinland/Köln
  - DWK, DAK, DGK, & DLK 250 by TÜV-Nord/Hamburg
  - Both institutes used different testing strategies and tools
  - The type test of the DWK 250 was based on KTA 3501, KTA 3505 and DIN V VDE 0801
- Finally an integration test of hardware and software was performed:
  - e.g. functions, characteristics, dynamic response, EMC
  - Some tests also under worst-case conditions

DWK 250 Neutron Flux Measuring Channel Features

- **Single detector for start-up, intermediate & power ranges**
- **10-12 decade measuring range w/up to 16 adjustable alarm set-points**
- **Both pulse & RMS-Campbell signal processing**
- **Wide range combining pulses & RMS signal**
- **Wide range signal calibration to neutron flux or power units (nv, P/Pn)**
- **Flux change rate calc. (1/reactor period)**
- **Signal filtering w/variable time constant**
- **Replaces traditional pulse & intermediate range channels**
- **Smaller "footprint" & isn't "power hungry"!**
- **Precise, Stable & Reliable**
- **Hardware & Software qualified Category A (IEC 61226)**

20+ years of successful operation in nuclear power plants and research reactors

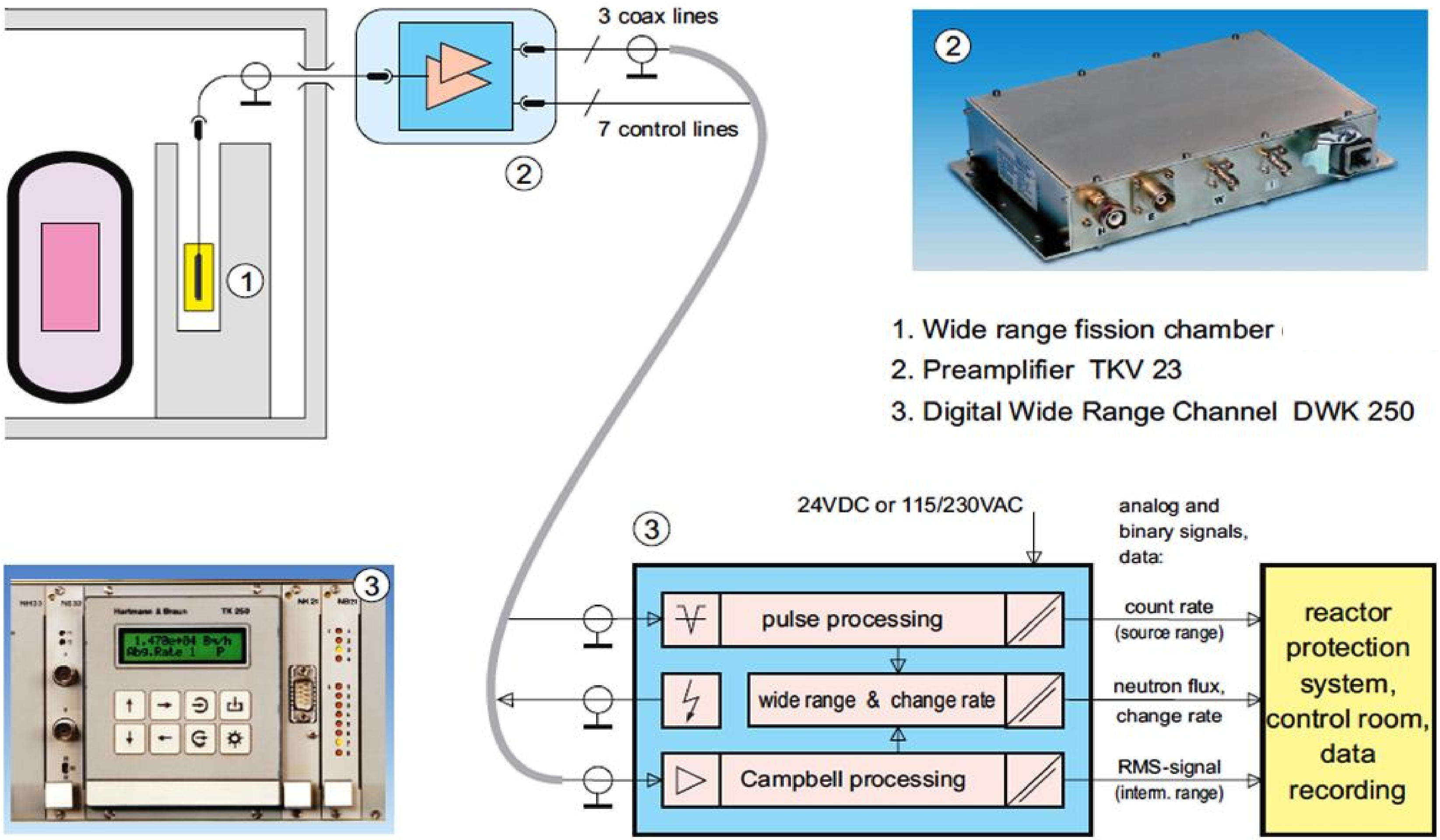
pulse & RMS-signal performed by a digital algorithm

Variety of self-checks provides highly reliable remote test generators and signal simulation for periodic testing.

DWK 250 Features (cont.)

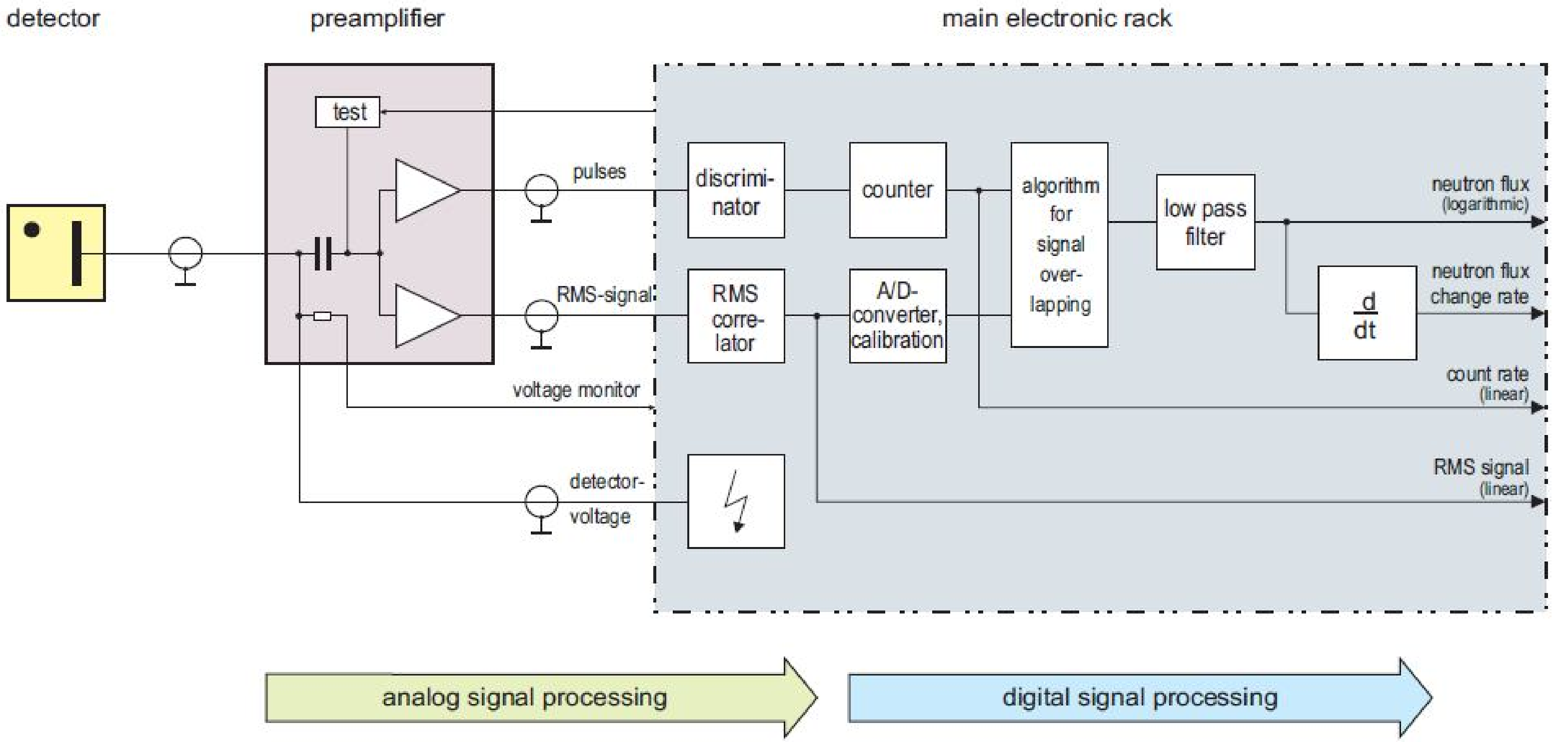
- Two analog outputs (linear or logarithmic), 8 binary outputs, defined by MIT
- Dedicated analog & binary output signals
- Remote test generators, also in preamplifier allows periodic testing w/o external equipment
- Digital adjustable parameters, lockable & non-volatile
- Full operation(e.g. testing)& data exchange via serial interface
- Continuous functional self checks

DWK 250 Wide Range Neutron Flux Monitoring



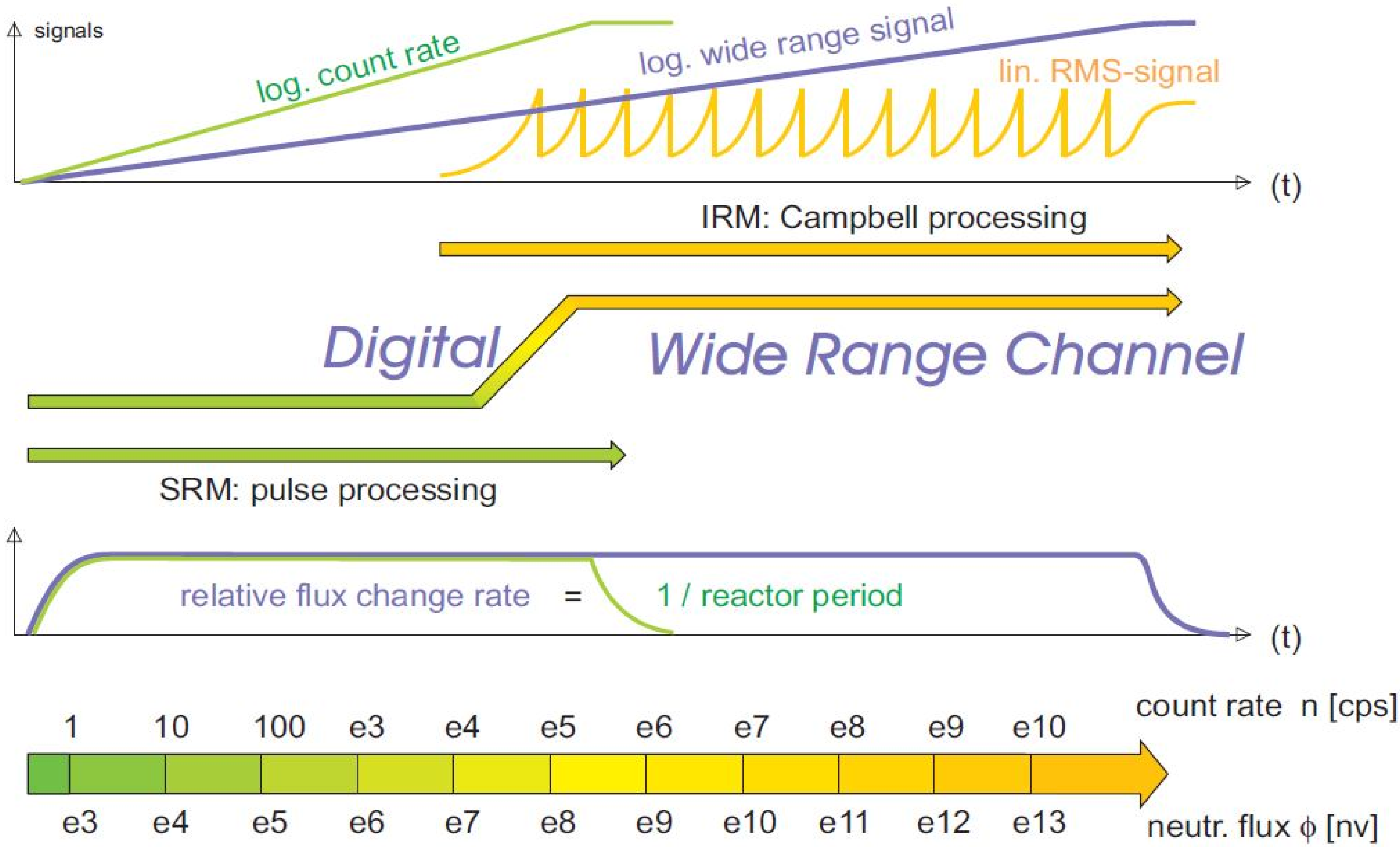
1. Wide range fission chamber
2. Preamplifier TKV 23
3. Digital Wide Range Channel DWK 250

DWK 250 Signal Paths



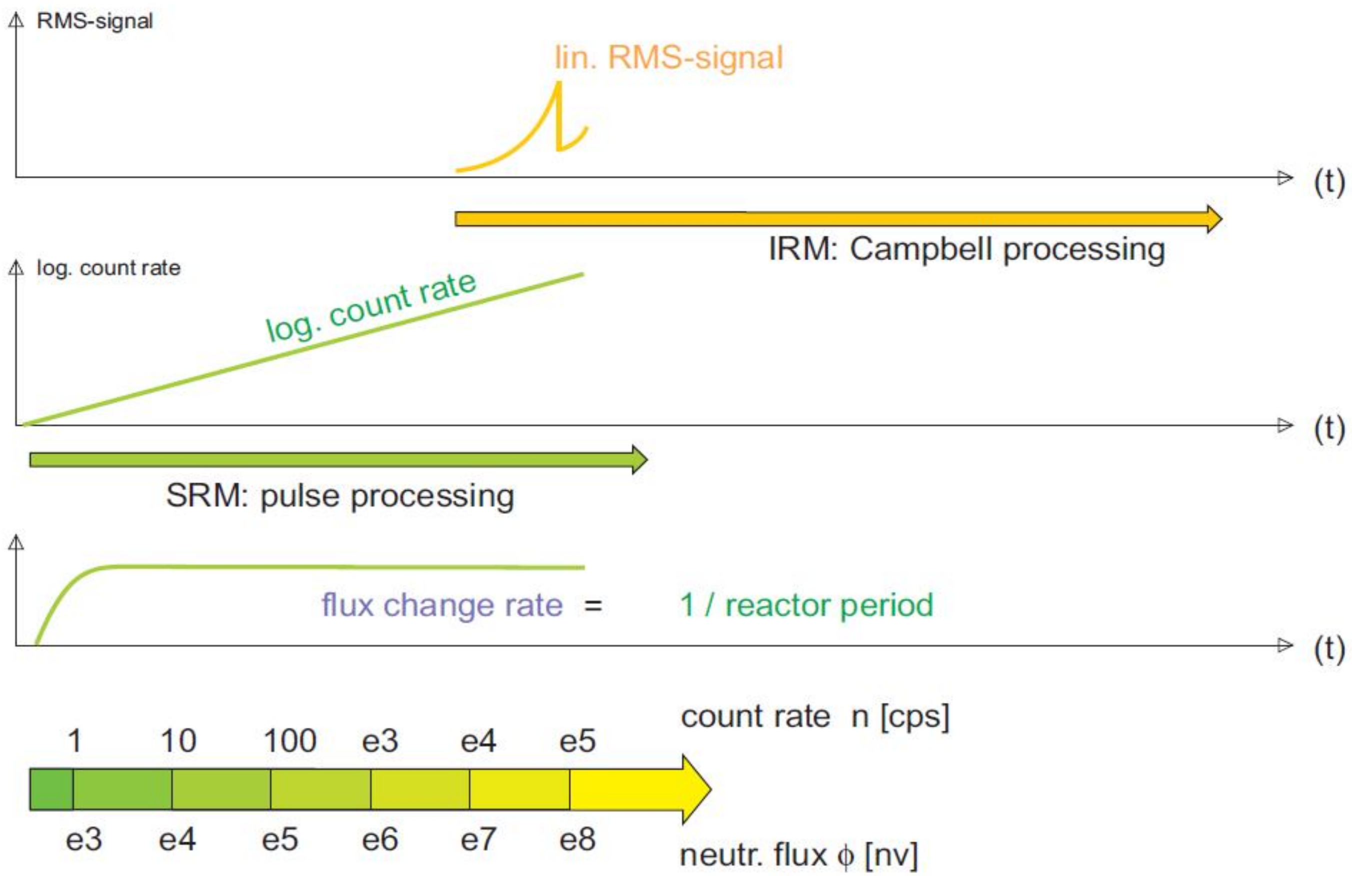
Start-Up

Reactor Start-up with DWK 250



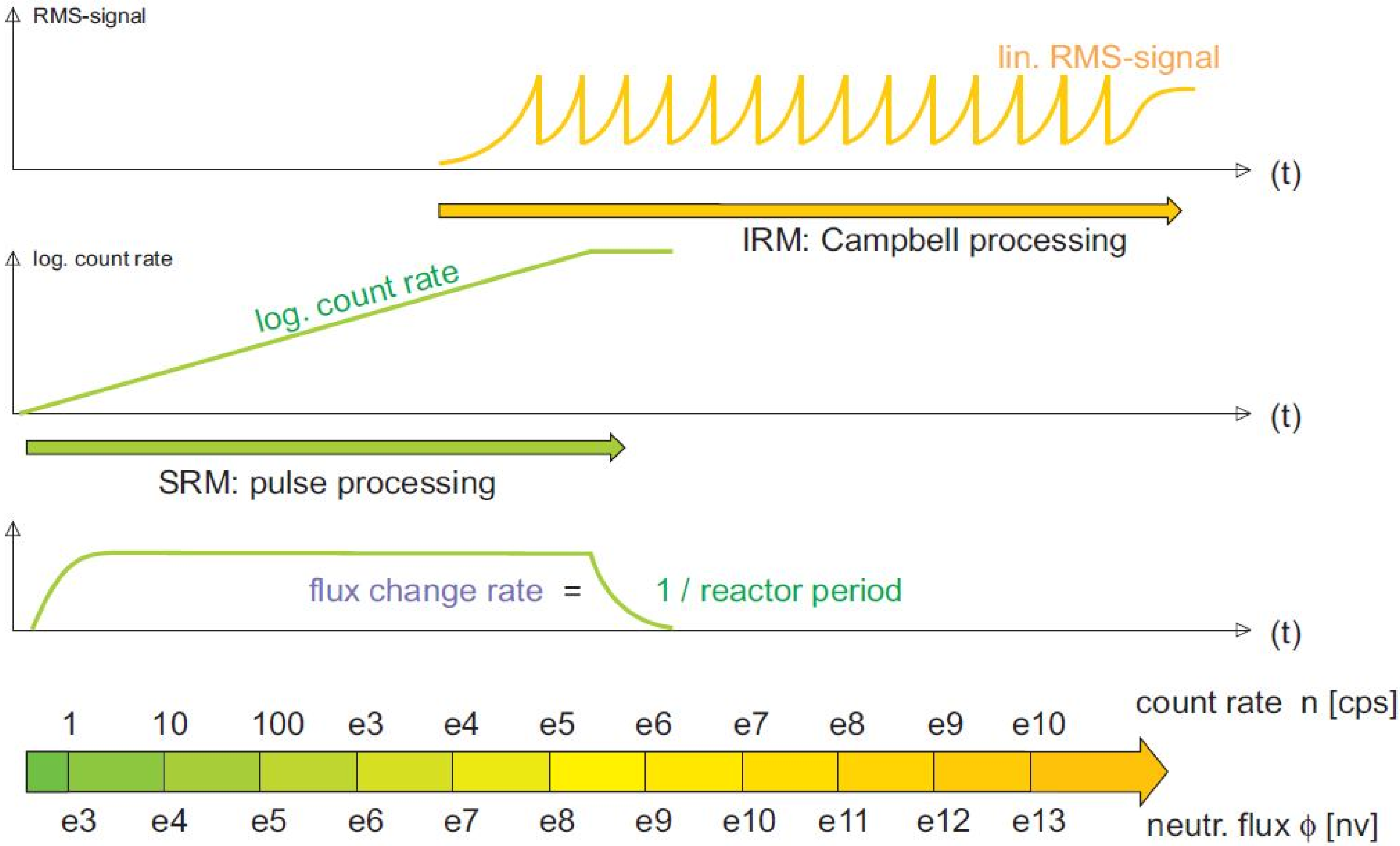
Pulse Range

Reactor Start-up: pulse range



Intermediate Range

Reactor Start-up: intermediate range



Campbell Signal Processing

What is Campbell signal processing?

applied in the DWK 250 in the intermediate range

- background: a very high number of detector pulses
  - no more can be counted individually
  - will be integrated to a fluctuating current (DC + AC)
- RMS-processing of the AC part (= fluctuation) of the detector current

uses the

Campbell-Theorem

(AC current)² ~ count rate ~ DC current

or $I_{AC}^2 \sim n \sim I_{DC} \sim \phi$

IEC 61501

- same detector as for the pulse range (fission chamber: robust, long life, LOCA proof)
- no influence of insulation current (I_{insul} is pure DC !)
- very good γ-discrimination (square of n / γ charge ratio)

Signal Processing

DWK 250 signal processing

Pulse range: processing of detector pulses

- pulse-discriminator with frequency pre-scaler 1:16
- pulse counter is part of the microprocessor
- analog & binary outputs: linear count rate and alarms for the RPS

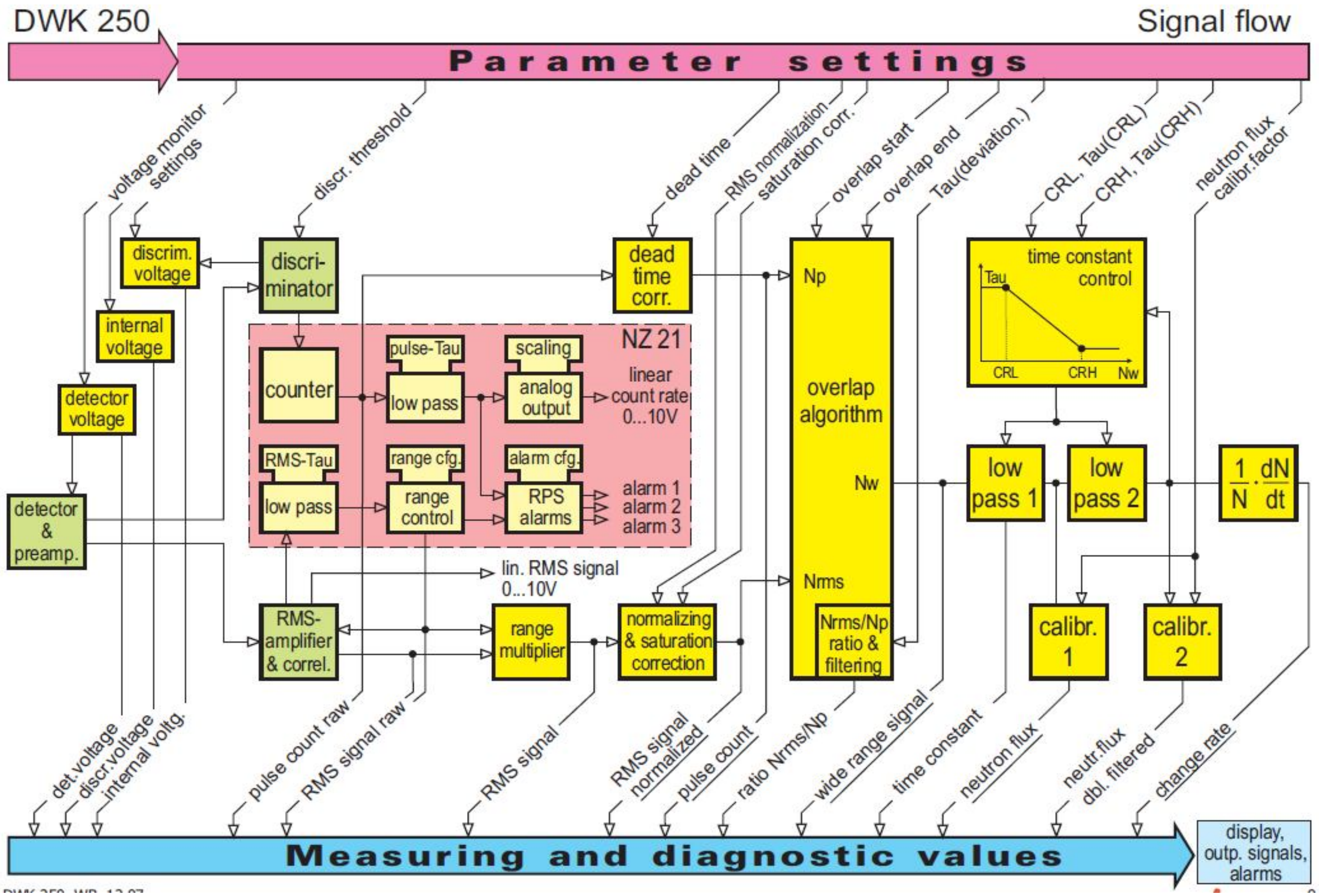
Intermediate range: RMS-processing

- fully analog signal processing
- linear output signal for the RPS, 16 ranges (= 8 decades)

Wide range: "wide range signal" generated by numerical overlapping of pulse signal and RMS-signal:

- smooth overlapping in a defined range to avoid transients
- wide range neutron flux output signal, e.g. 10 decades logarithmic
- continuous calculation of the flux change rate (= 1 / reactor period)
- remote test signals for both signal paths

DWK 250 Flow Diagram



DWK 250 Software Menu

Menu Table — DWK 250

Meas.values	Status	Parameters	Testing	Diagn.values
* Neutron flux 1,234e+12 nv Change rate +12,34e-2 1/s Pulse count 1,234e+05 cps RMS signal 1,234e+12 cps Wide range sign. 1,234e+12 cps ** default position*	Alarms: Which alarm has triggered? Faults: CPU NZ21 arithm.NZ21 overflow RAM NZ21/NZ12 EPROM NZ21/NZ12 PAR_RAM NZ12 S-Bus detector voltage internal voltages discrim. voltage testing locked Software-Ident.: DWK 250 3100 347A K001	General settings: Time constants: Voltage monitor: Alarm settings: Analog outputs: Select dimensions: Plant code: Default param.s:	Binary outputs: BO # 1...8 -> 0/I Test generators: preamp. off/pulse/RMS discriminator off/F1/F2 RMS-input off/on Simulation: pulse count RMS-signal norm. analog output 1/2 Global test status: normal / test Display: all pixels active Watchdog: be aware: causes a restart of the system!	N.flux doubl. filtered pulse count raw RMS signal raw RMS signal ratio Nrms/Np time constant detector voltage internal voltage discrim. voltage checksum NZ21 checksum NZ12 BI-status NZ21/12 alarm-status NZ21

(MGPI H&B) GmbH, Munich
QUALITY ASSURANCE POLICY

MIRION
TECHNOLOGIES

Radiation Monitoring Systems Division
Mirion Technologies (MGPI H&B) GmbH, Munich

Quality Assurance Policy

Christine Renn

2012-10-02

Table of Contents

QA Policy in the Quality Manual demonstrates the process-oriented management system of MGPI H&B

Quality Manual

gives an general overview of the structure and processes of Mirion Technologies (MGPI H&B) GmbH

Process Descriptions

includes company processes and the determination of areas responsibility; the processes can be divided into four different groups

1. Business Processes
2. Supporting Processes
3. Management Processes
4. Quality Assurance Processes

Structure of the documentation of the QA-System

Procedures, Operational Instructions…..

contains regulations on particulars as well as detailed instructions relating to the job functions

Quality achievements are verified by those who are not responsible for performing the work

October 2012

General Management

Radiation Protection
Export Control
Environment Protection
Safety at work / Data Security

Finance & Controlling
- Accounting
- Controlling
- HR / Admin
- IT
- *Receptionist*

7

Project Management and Sales
- PM / Intern. Sales Support
- Nat. Sales
- Sales Controlling

8

R&D / Engineering
- Systems & Detector Dev.
- Electronic Dev.
- Software Dev.

10

Industrial Engineering
- Purchasing
- Logistic
- Industrial Engineering

6

Production
- Planning
- Elect. Assembly
- Elect. Manuf.
- Detector Assembly
- Mech. Manuf.

11

Test & Service
- Testbay
- Service

7

Quality Management
- Quality Management
- Documentation
- Document-Management
- Export Control Environment
- Protection
- Safety at work

4

Total of 54 FTE
1 Managing Directors & Vice President
7 Manager
44 Employees
2 Temporary
Students are not included

Quality Assurance System according to NRC 10 CFR part 50B and part 21 is audited and certified by Tractebel, Belgium

TRACTEBEL Engineering
GDF SUEZ

CERTIFICATE OF AUTHORIZATION
nr. **2648**

This is to certify that
Mirion Technologies GmbH Kernstrahlungsmesstechnik, in München, Germany

is hereby authorized[1] to act as **Manufacturer and repair organization,** in accordance with the applicable rules of

10 CFR50 Appendix B

This authorization is granted on the basis of the Qualitätsmanagement-Handbuch (QMH) reference 0348 250, which scope and implementation have been reviewed and accepted by Tractebel Engineering on April 9th, 2010 (see audit report n°. 10/016 - CNT-KCD/4FR/15833/000/00)

for the design, procurement, fabrication, examination, testing, repair, storage, handling and shipping of

Radiation Monitoring Systems qualification levels 1EA, 1EB and 1EC; RSQ : 18.xx, 19.xx, 33.xx,34.xx and 35.xx.

at the above location from June 20th, 2009 until March 1th, 2013

Jos SLECHTEN
Qualification Manager Nuclear

Luc RESTEIGNE
Executive Vice-President Nuclear

1 This authorization does not relieve its holder from his contractual obligations towards the Owner. By this authorization, Tr actebel does not "approve", "certify", "rate", or "endorse" any product or construction.

N23-AM-06-E | AUTHORI/4Q/2648-00 | CA/MGPAL | CQR: 923 | RSQ: 18.xx-19.xx-33.xx-34.xx-35.xx

Standard Quality Assurance requirements according ISO 9001:2008 are implemented and certified

CERTIFICATE

DQS GmbH
Deutsche Gesellschaft zur Zertifizierung von Managementsystemen

hereby certifies that the company

MGPI H&B

Mirion Technologies (MGPI H&B) GmbH
Landsberger Straße 328A
80687 München
Germany

has implemented and maintains a **Quality Management System**.

Scope:
Development, sales, project engineering, design, manufacturing, final inspection, documentation and service (start up, training, maintenance, repairs) of electrical and mechancial instruments and systems in the field of nuclear measurement

Through an audit, documented in a report, it was verified that the management system fulfills the requirements of the following standard:

ISO 9001 : 2008

Certificate registration no.	281024 QM08
Date of certification	2010-03-04
Valid until	2013-03-03

TGA-ZM-02-90

Michael Drechsel, Managing Director
Jan Böge, Managing Director

August-Schanz-Straße 21, 60433 Frankfurt am Main

IQNet
THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

IQNet and
DQS GmbH Deutsche Gesellschaft zur Zertifizierung von Managementsystemen
hereby certify that the company

Mirion Technologies (MGPI H&B) GmbH
Landsberger Straße 328A
80687 München
Germany

has implemented and maintains a **Quality Management System**.

Scope:
Development, sales, project engineering, design, manufacturing, final inspection, documentation and service (start up, training, maintenance, repairs) of electrical and mechancial instruments and systems in the field of nuclear measurement

Through an audit, documented in a report, it was verified that the management system fulfills the requirements of the following standard:

ISO 9001 : 2008

Date of certification	2010-03-04
Valid until	2013-03-03

Registration Number: DE-281024 QM08

René Wasmer
President of IQNet

Ass. iur. M. Drechsel *J. Böge*
Managing Directors of DQS GmbH

IQNet Partners*:
AENOR *Spain* AFAQ AFNOR *France* AIB-Vinçotte International *Belgium* ANCE *Mexico* APCER *Portugal* CISQ *Italy* CQC *China* CQM *China* CQS *Czech Republic* Cro Cert *Croatia* DQS *Germany* DS *Denmark* ELOT *Greece* FCAV *Brazil* FONDONORMA *Venezuela* HKQAA *Hong Kong China* ICONTEC *Colombia* IMNC *Mexico* Inspecta Certification *Finland* IRAM *Argentina* JQA *Japan* KFQ *Korea* MSZT *Hungary* Nemko AS *Norway* NSAI *Ireland* PCBC *Poland* Quality Austria *Austria* RR *Russia* SAI Global *Australia* SII *Israel* SIQ *Slovenia* SIRIM QAS International *Malaysia* SQS *Switzerland* SRAC *Romania* TEST St Petersburg *Russia* YUQS *Serbia*

IQNet is represented in the USA by: AFAQ AFNOR, CISQ, DQS, NSAI Inc. and SAI Global

* The list of IQNet partners is valid at the time of issue of this certificate. Updated information is available under www.iqnet-certification.com

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Mirion offers an array of solutions and services for managing radiological hazards.

Learn more at: **www.mirion.com**

MIRION TECHNOLOGIES

Radiation Monitoring Systems Division

German NPP Quality Assurance Requirements according KTA 1401 are confirmed by the authorities

Confirmation on quality assurance according to nuclear standard KTA 1401

On behalf of the German nuclear power plant operators RWE Power AG as a partner of the VGB PowerTech e.V. working group "Assessment of Contractors" confirms

Mirion Technologies (MGPI H&B) GmbH
Landsberger Str. 328a, 80687 München

true for the site

80687 München

and the scope of supply and services

development, sales, project engineering, design, manufacturing, final inspection, documentation and service (training, maintenance and repair) of electrical and mechanical instruments and systems in the field of nuclear measurement

the qualification for system- and product related quality assurance.

The assessment was performed on 04.03.2010 by order of

AHA Ingenieurdienstleistungen GbR

based on the standard **KTA 1401** as well as on the assessment documents of the VGB PowerTech e.V. working group "Assessment of Contractors" in consideration of product related requirements.

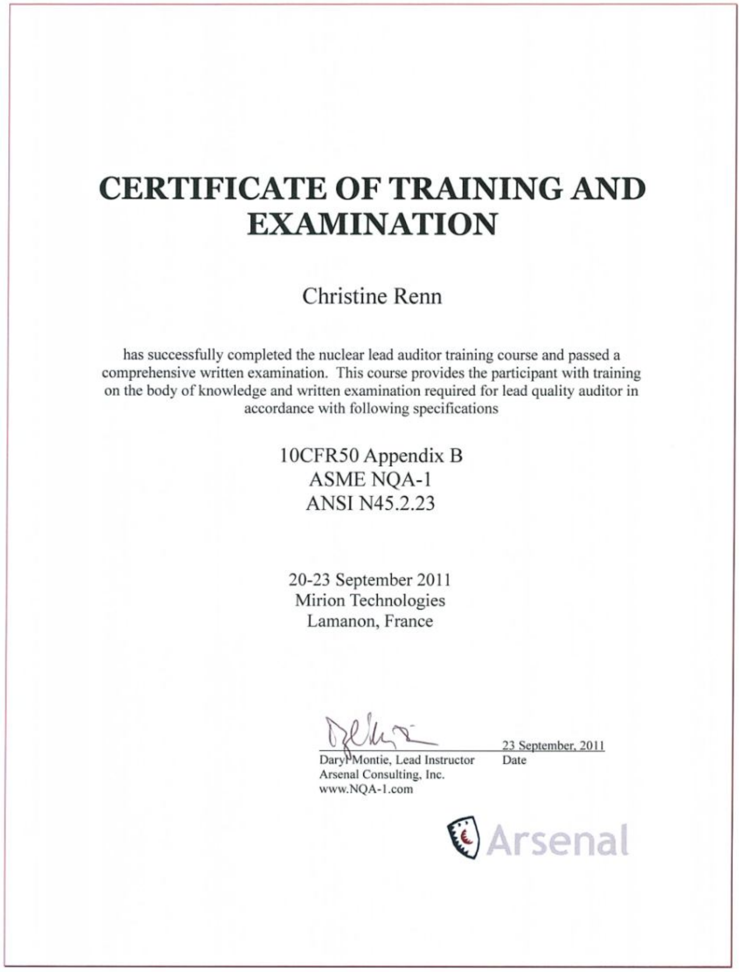
Details of the assessment are given in the report **AHA 02/2010**.

This confirmation is valid until **March 26th, 2013** provided that the conditions on which the assessment was based have not been changed.

Essen, 25.03.2011

RWE Power AG

QA Manager is trained according the 10 CFR 50 App. B and fulfils the lead auditors requirements



CERTIFICATE OF TRAINING AND EXAMINATION

Christine Renn

has successfully completed the nuclear lead auditor training course and passed a comprehensive written examination. This course provides the participant with training on the body of knowledge and written examination required for lead quality auditor in accordance with following specifications

10CFR50 Appendix B
ASME NQA-1
ANSI N45.2.23

20-23 September 2011
Mirion Technologies
Lamanon, France

Daryl Montie, Lead Instructor
Arsenal Consulting, Inc.
www.NQA-1.com

23 September, 2011
Date

Arsenal

Extract of the examination content

The examination content is written to meet the requirements of NQA-1, 10 CFR 50 Appendix B, and ANSI N45.2 and includes questions to ensure that the participant has comprehension of and the ability to apply knowledge of the following:

- Nuclear standards including NQA-1, 10 CFR 50 Appendix B, ANSI N45.2 and other nuclear-related codes, standards, regulations, and regulatory guides, as applicable
- The ability to interpret the requirements and apply them to situations
- General structure of quality assurance programs as a whole and applicable elements
- Auditing techniques of examining, questioning, evaluating, and reporting
- Methods of identifying and following up on corrective action items and closing out audit findings
- Planning audits of activities affecting quality

Software Quality Assurance is described and defined in the Software Quality Assurance Plan (SQAP) and shows compliancy to the IEEE 730

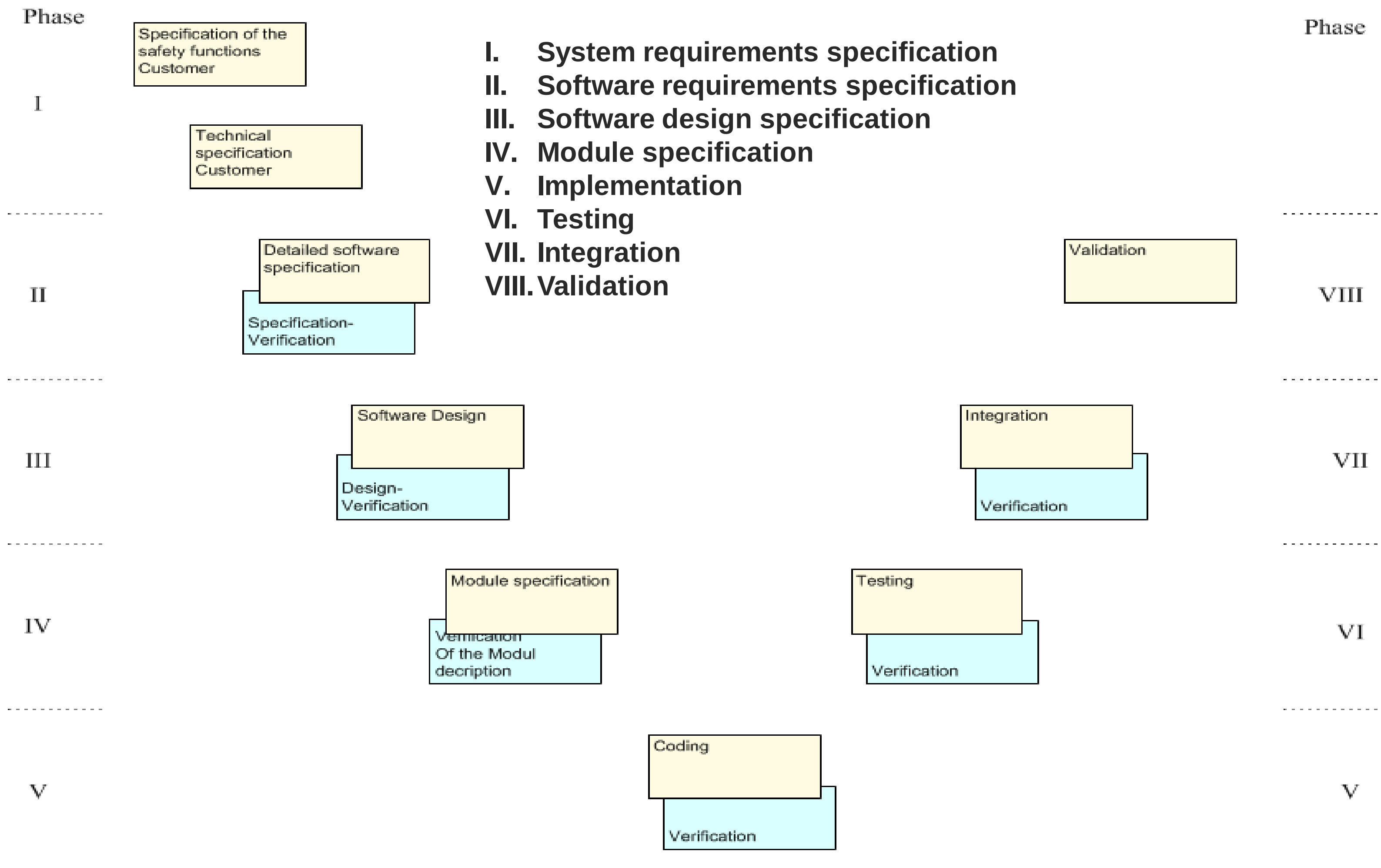
Purpose of the SQAP

- Describes and defines the procedures used during the software development process for the TK 250 system
- Identifies the documentation during the development, verification, validation, use and maintenance of the software product
- Describes the organizational elements responsible for the origination, verification, validation, maintenance and control of the required documentation
- Shows compliancy to the IEEE 730 standard (ref. to /2.9/) and with all demands from the IEC 60880 §5.5 ref. to /2.5/
- Applies to the software of those TK 250 systems, which are designed for the use in IEC 61226 category A or 1E applications (DAK 250, DGK 250, DWK 250, DMK 250, DSK 250, DLK 250)

SQAP covers the following phases of the software life cycle

- Specification
- Design
- Implementation
- V&V
- Installation
- Commissioning
- Operation and maintenance

Based on V-Model of IEC 60880 the software development process is divided into 8 different phases; each phase has to be finished and reviewed before the next phase can be started



- I. System requirements specification
- II. Software requirements specification
- III. Software design specification
- IV. Module specification
- V. Implementation
- VI. Testing
- VII. Integration
- VIII. Validation

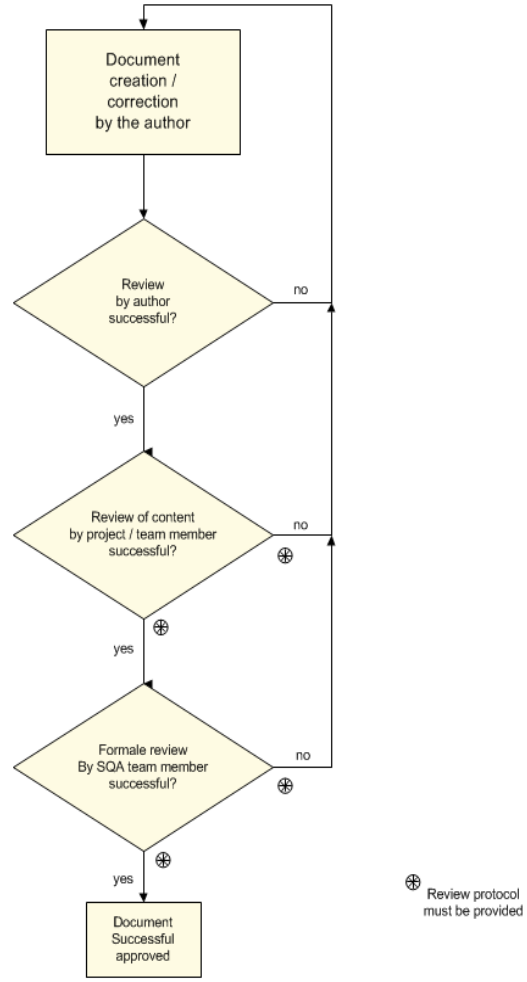
MGPI H&B documents are reviewed, updated & approved by independent authorized persons

Every document has to be approved by the following participants

- the author(s), to check for the correct content and the correct form
- a team member, or project member to check and sign for the correct content
- a member of the QA team to check and sign for the correct form

A verification report is created which contains information about

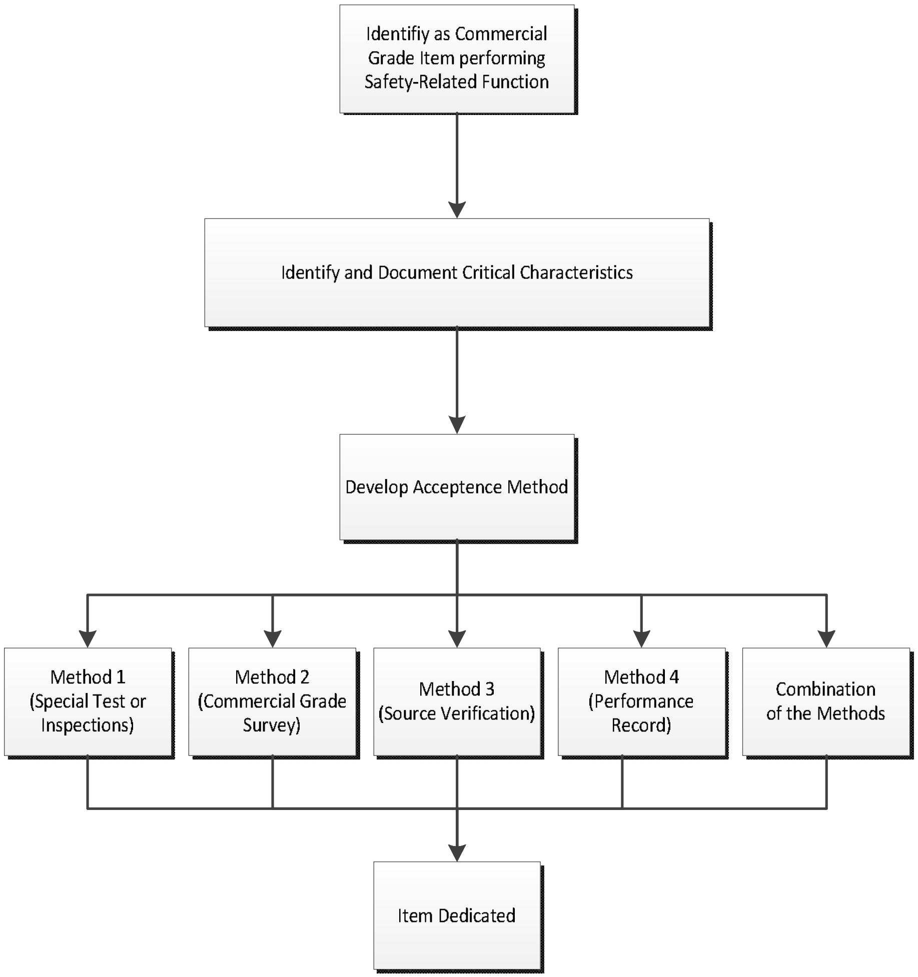
- the reviewer
- the reviewed activities and
- the reviewed results

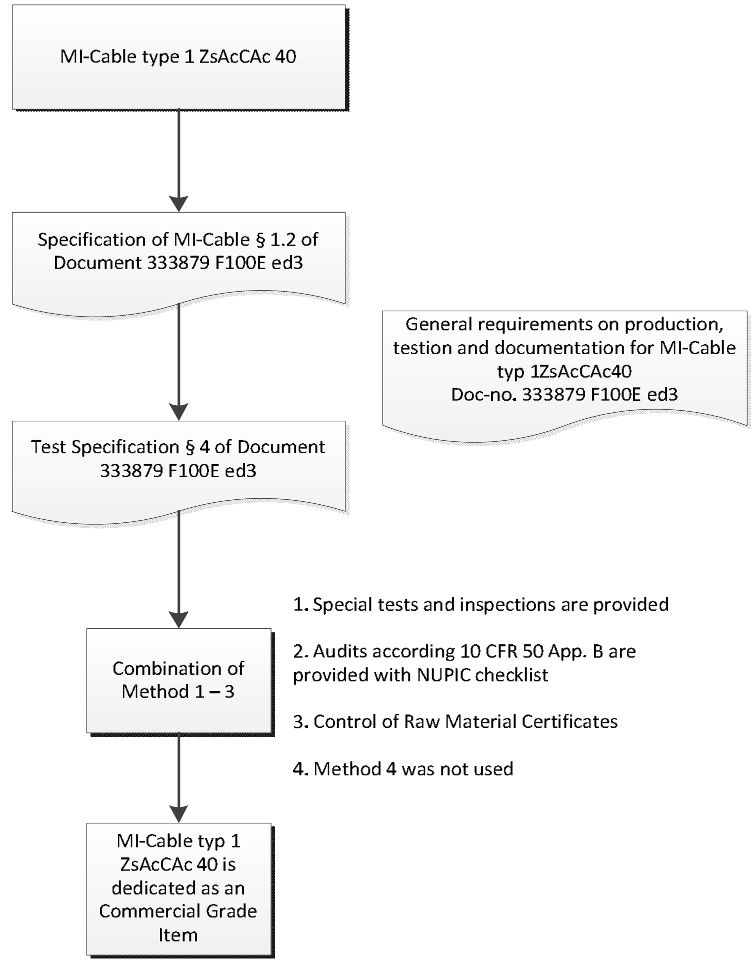


Handling, storage & shipping if items are conducted in accordance with established instructions

- When required for critical, sensitive, or high-value articles, specific procedures for handling, storage, packaging, shipping and preservation are provided
- When required special handling tools and equipment is utilized and controlled to ensure safe and adequate handling
- Operators of special handling are experienced and trained
- Instructions for marking and labeling for packaging, shipment, handling and storage of items are established

MI-Cable type 1 ZsAcCAc 40 was dedicated as a Commercial Grade Item





Purpose of Mirion Export Management and Compliance Program (EMCP) is to ensure that employees are consistently making the right export decisions

- **Mirion EMCP includes the following information which applies to all sites, followed by separate section that relate to the local laws of each country in which Mirion has a site:**
  - Management Commitment & Responsible Employees
  - Mirion Risk Assessment
  - Product Classification
  - Screening
  - Maintenance of Records
  - Auditing of Export Management and Complience
  - Training
  - Site Implementation
- **The EMCP was fully implemented and audited in March 2011 at Mirion (MGPI H&B); the export control process is documented and trained on the procedure 0348661 A 12 ed1**
- **An export license from the German authority (BAFA) is required for the delivery of the equipment; End customer and end use has to be known; Delivery without export license is not possible**

Status Update on PLCs

- Use of industrial PLCs that have been approved by NRC, SIL 2 – SIL 4, qualification 1E
- Use of industrial PLCs that have not been previously approved by NRC

License Amendment

- SAR Revision
- Amendment to Technical Specifications
- Projected Schedule

Documentation Content

- Technical Report on DWK250
- Information on PLCs to be used
- Final logic circuit design & testing plan

NRC Guidance on Reviewing Digital I&C Systems for Non-Power Reactors

- MIT plans to document the new Mirion system as a change to the MITR Safety Analysis Report via 10 CFR 50.59 review, using NUREG 1537 and its newly proposed changes as guidance
- Changes within the 50.59 envelope are reported annually to NRC but do not require NRC approval prior to implementation; changes beyond the 50.59 envelope require license amendment and therefore do require prior NRC approval
- Potential mechanism is for NRC to require either an amendment to the Tech Specs or an entirely new section defining a new envelope of operation

Concluding Material

- Questions & Comments

- Contact Info:

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Cambridge, MA 02139

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eslau@mit.edu