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Motion Control System Base Requirements for NScD Neutron Instruments

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Revision	Description of Changes
A	Initial Draft for review and comment
0	Initial Release

1. Introduction

This document provides minimum requirements for the Neutron Sciences Directorate (NScD) neutron instrument suite motion control systems to support standardization in the areas of compatibility, interchangeability, and consistency across the NScD instrument suite. Adhering to these minimum baseline requirements reduces cost of spares inventory, supports reduction of instrument downtime, improves efficiency during design, integration, and troubleshooting and improves overall system quality.

Final motion system requirements for individual instruments including requesting deviations from these minimum standard requirements shall be reviewed with NScD subject matter experts. Contacts can be found on IE-Wiki under 60 Data Acquisition Section.

https://ie-wiki.ornl.gov/dokuwiki/doku.php?id=wbs:daq:start

2. Scope

This document outlines the minimum base requirements for all motion control systems designed and implemented on neutron instruments in NScD.

2.1 REQUIREMENTS

2.1.1 Controllers shall be supported with current EPICS drivers.

Rationale: Enables integration without significant software development effort.

2.1.2 (SNS specific) For system designed for SNS instrument the control system should be wall mounted.

Rationale: Improves access for troubleshooting and repairs when wall space is available.

2.1.3 (HFIR specific) For system designed for HFIR instrument the control system should be rack mounted.

Rationale: Due to lack of wall space on HFIR instruments rack mounted systems provide better integration into the available spaces outside of radiation areas.

2.1.4 All stepper motor and control systems should not exceed 48V DC.

Rationale: Ensures systems are within standard power requirements for most stepper motors.

2.1.5 Controller shall not be located within <u>high</u> radiation areas.

Rationale: Improves access for troubleshooting and repair and extends life and reliability of systems.

2.1.6 Drive shall not be located within <u>high</u> radiation areas.

Rationale: Improves access for troubleshooting and repair and extends life and reliability of systems.

2.1.7 Controller should not be located within a radiation area.

Rationale: Improves access for troubleshooting and repair and extends life and reliability of systems.

2.1.8 Drive should not be located within a radiation area.

Rationale: Improves access for troubleshooting and repair and extends life and reliability of systems.

2.1.9 Drive to motor length should not exceed 90ft (~27meters).

Rationale: Minimize voltage drop along cable. Cable shall be of sufficient wire gauge to minimize voltage drop.

2.1.10 All field cables shall be shielded to prevent electrical interference.

Rationale: Supports manufacture recommendations to prevent cross talk and introduction of noise into the system. Improves performance and reliability.

2.1.11 Cable routing and material selection shall consider radiation levels.

Rationale: Radiation exposure breaks down standard cabling insulation leading to failures.

2.1.12 Motors shall be NEMA frame specification.

Rationale: Supports standardization and spares management.

2.1.13 Stepper motors should not exceed 6A.

Note: Previous generations of controllers had lower limits. When reusing an existing controller in a new design / upgrade check with SME on limits.

Rationale: Is supported by standard Galil controller without use of external drive.

2.1.14 Stepper motors should be selected for instrument designs.

Rationale: Reduces complexity and integration effort.

2.1.15 Encoder location and selection shall consider radiation levels

Rationale: Encoders with optical read heads fail quickly in radiation areas. Consult SME when placing encoder in radiation area.

2.1.16 Encoder location and selection shall consider magnetic stray fields.

Rationale: High magnetic fields can cause encoder failures. Consult SME when placing encoder in magnetic fields.

2.1.17 BiSS communication protocol shall be selected for <u>absolute</u> encoders.

Rationale: Supports standardization with standard motion controller panels and EPICS setups. If a different communication protocol is needed consult SME prior to selection. (impacts wiring and software integration).

2.1.18 Quadrature differential interface shall be selected for incremental encoders.

Rationale: Supports standardization with standard motion controller panels and EPICS setups. If a different communication protocol is needed consult SME prior to selection. (impacts wiring and software integration).

2.1.19 Designs should select components from approved hardware list.

Rationale: Supports standardization improving efficiency in designs, integration, troubleshooting, and spares inventory.

2.1.20 Designs shall incorporate end of travel limit switches.

Rationale: Reduces risk of equipment damage.

2.1.21 Linear axes should be provided with mechanical hardstop.

Rationale: In the event of wiring or software error during integration or switch failure mechanical hardstops are critical to prevent equipment damage and minimize risk of creating potential safety hazards.

2.1.22 Designs should incorporate roller plunger or roller lever mechanical limit switches (not active switches).

Rationale: Improves performance and lifetime in radiation and/or high magnetic field areas and supports standard field wiring.

2.1.23 Control system power requirements per chassis should not exceed 120VAC, 20A.

Rationale: Improves integration and potentially reduces cost due to availability of common power source.

2.1.24 Systems should complete and document offline acceptance testing prior to installation.

Rationale: Reduces installation and commissioning time. Acceptance testing documentation should be transmitted to record copy system.

2.1.25 Systems shall complete integration testing on the beamline prior to neutron beam commissioning.

Rationale: Reduces commissioning time, downtime on the instrument, and staff exposure to radiation (ALARA).

2.1.26 Interlocks (including E-stops) shall be defined during conceptual design.

Rationale: Integration of interlocks in a motion control system requires 'special' (non-standard) *designs that must be integrated during initial design and assembly of systems.*