1.18 Instrumentation and control personnel shall demonstrate a familiarity level knowledge of the geoseismic/civil engineering theories, principles, and techniques that apply to instrumentation and control systems.

Supporting Knowledge and/or Skills

a. Discuss the seismic design constraints imposed on instrumentation and control systems important to safety.

Instrumentation and Control (I&C) system design must consider the following seismic factors. First, the potential seismic loading on the system must be identified. This will include both examination of the probability of a seismic event and a conservative estimate of the severity of the event (these two factors define the design basis earthquake (DBE)). Once the DBE is characterized, the response to the earthquake must be determined. The amplitude (maximum ground movement) and frequency (how often the ground moves) is calculated. The response level, the movement of the structure relative to ground movement, will then be determined. Dissipation and damping due to the materials and mass of the structure which the I&C system is housed are the two primary variables which effect the response level. The elastic properties of the structure are then determined. With these parameters, the particular system design can then be determined.

Equipment used in the safety systems must be shown to be able to withstand the resulting forces determined by the methodology presented above. Particular equipment response can be determined from testing data or experience data (performance response data available on equipment from past earthquakes and from past qualification testing). The other major consideration is equipment anchor design. This is vital to ensure that the force seen by the equipment is not amplified due to wave action.

b. Describe the function and operation of instrumentation systems used to measure and enunciate seismic events at defense nuclear facilities.

Facilities or sites which have structures, systems , or components in Performance Category (PC) 2 (with hazardous material), PC 3 or PC 4 shall have instrumentation or other means to detect and record the occurrence and severity of seismic events. These systems measure ground acceleration and provide an alarm when it measures acceleration above a threshold value. The purpose of this is to provide indication and a record of seismic events so that a thorough damage inspection may be completed.

c. Discuss the effects of vibration on instrumentation and control system performance and reliability, including the methods used to mitigate those effects.

Vibration may effect the operation of instrument and control systems by introduction of calibration or setpoint error on mechanical and analog electrical components. Additionally, it may also cause failure in wiring connection and at pin connections in solid state or digital systems. Vibration effects may mitigated by using vibration or shock

mounts. Two factors must be considered. From a seismic design perspective, a rigid coupling is necessary to properly anchor the equipment during low frequency vibrations associated with earthquakes. The single most important factor for survivability of I & C systems during an earthquake is rigid anchoring of the system components. However, rigid anchors transmit high frequency vibrations directly to equipment possibly producing the effects discussed above. Semi-rigid or vibration damping mounts may be used to anchor the equipment but not transmit vibrations.

d. Discuss the general factors that affect the seismic qualification of a system, component, or structure.

Seismic qualification is the documented assurance that a system, component, or structure can continue to perform its required function following a seismic event. The level of qualification is affected by the facility hazard classification and structure, system or component safety classification. For example a safety related instrument is a high hazard category facility may require a higher level of qualification and quality assurance than the same instrument in a lower hazard category facility.

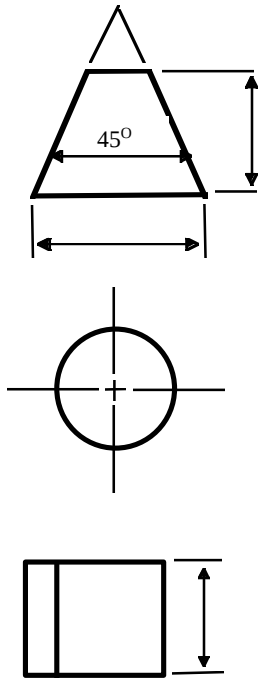
1.22 Instrumentation and control personnel shall demonstrate the ability to read and interpret engineering fabrication, construction, and architectural drawings.

Supporting Knowledge and/or Skills

a. Given the above drawings, read and interpret the following symbology:

This is a demonstration requirement. The following tables are provided as examples of graphic symbology. Always check the legends on the controlled drawings that are applicable to the project, since different architects and software packages may use unique symbology.

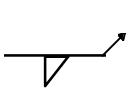
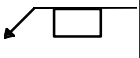
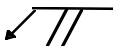
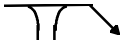
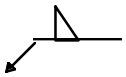
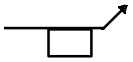
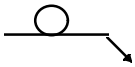
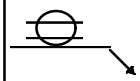
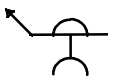
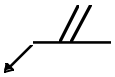
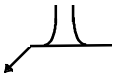
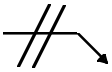
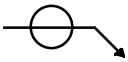
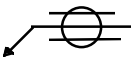
- Basic dimensional and tolerance



Geometric characteristic symbols

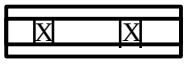
	Type of Tolerance	Characteristic	Symbol
For individual features	Form	Straightness Flatness Circularity (roundness) Cylindricity	
For individual or related features	Profile	Profile of a line Profile of a surface	
For related features	Orientation	Angularity Perpendicularly Parallelism	
	Location	Position Concentricity	
	Runout	Circular runout Total runout	a

- Basic fabrication

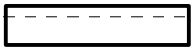
Basic Welding Symbols and Their Location Significance								
	Fillet	Plug or Slot	Spot or Projection	Seam	Back or Backing	Surfacing	Scarf for Brazed Joint	Flange Edge
								
						Not used		
		Not used	Not used	Not used	Not used	Not used		Not used
	Not used	Not used			Not used	Not used	Not used	Not used

- Basic fabrication

STEEL STUD

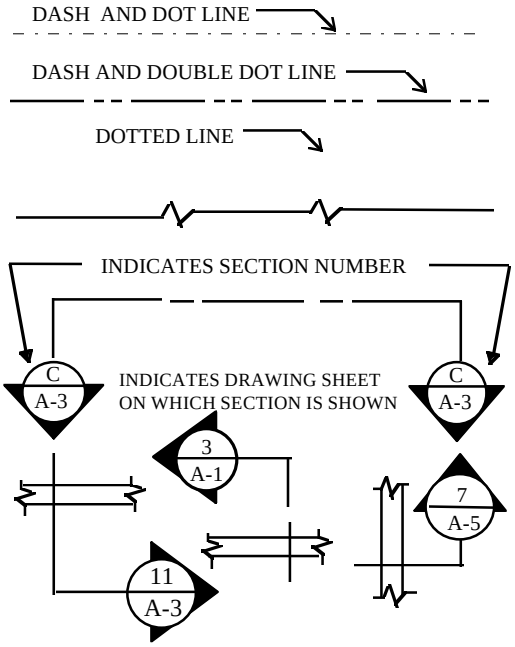


WOOD STUD



DASHED LINE DENOTES SPECIAL FINISH FACE - PLAN/SECTION

- Basic architecture



CENTER LINES, FLOOR LINES IN EXTERIOR ELEVATIONS, PROJECTED LINES

PROPERTY LINES, BOUNDARY LINES

CUT LINE OR HIDDEN LINE

TO BREAK OFF PARTS OF DRAWINGS

SECTION LINES AND SECTION REFERENCES

b. Given a drawing and a completed or partially completed product, compare the product against the specifications on the drawing.

This is a demonstration skill.

Use the information represented on the drawings to check dimensions on all elevations and plans, sizes, shape, locations (if applicable), materials, assemblies, equipment, fabrication, finishing, tolerances, and any other information called out on the drawings.