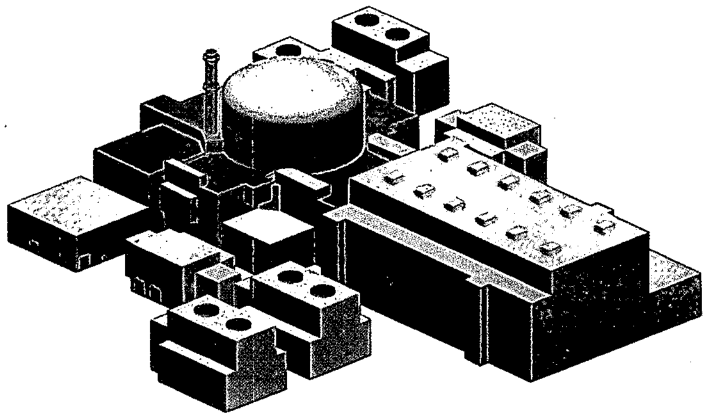
U.S. Evolutionary Power Reactor

U.S. EPR™ Plant



U.S. EPR Local Control Station (LCS) Style Guide

U.S. EPR Doc. No.: XXXXX - XXX - XXX - XXXX - XXXXX - XXX

AREVA NP Doc. No.: 117 - 9097806 - 000

RECORD OF REVISIONS

Safety Related? ☐ YES ☒ NO

Revision No.	Date	Pages/Sections/ Paragraphs Changed	Brief Description / Change Authorization
000	1/21/09	All	Initial Release

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LIST OF TABLES

1.0 APPLICABILITY

This Local Control Station (LCS) Style Guide applies to all New Plants Deployment engineering disciplines.

2.0 OWNER

Program Manager, Human Factors Engineering (HFE) and Control Room Design

3.0 PURPOSE

The purpose of this guide is to establish human factors guidance and provide a consistent approach to the design of LCSs for the U.S. EPR which satisfies the Quality Assurance plan, the Design Control Procedures, the U.S. EPR Project Plan, and the Nuclear Regulatory Commission (NRC) regulatory guidelines.

4.0 SCOPE

The scope of this guide includes the following:

- Human Characteristics
- Local Control Station Design
    - Control, indication, alarm and security
    - Labeling
    - Communications
    - Workstation Factors
        - Accessibility
        - Workstation envelope
        - Environment (lighting, temperature, and noise)
        - Risk Factors for Musculoskeletal Disorders (MSDs)
- Personal Protective Equipment

5.0 ACRONYMS AND DEFINITIONS

5.1 Acronyms

ALARA	As-Low-As-Reasonably-Achievable

CY	Communication System
HFE	Human Factors Engineering
HRA	Human Reliability Analysis
HSI	Human System Interface
I&C	Instrumentation and Control
I&CSC	Instrumentation and Control Support Center
KPF	Liquid Waste Processing System
KPK	Liquid Waste Storage System
LCS	Local Control Station
LOOP	Loss of Offsite Power
MCR	Main Control Room
MSD	Musculoskeletal Disorder
NRC	Nuclear Regulatory Commission
NUREG	Publications Prepared by the NRC staff
PICS	Process Information and Control System
POP	Plant Overview Panel
PPE	Personal Protective Equipment
QDS	Qualified Display System
RSS	Remote Shutdown Station
SDD	System Description Document
SICS	Safety Information and Control System
TSC	Technical Support Center

5.2 Definitions

ALARA	As Low As Reasonably Achievable (ALARA). Making every reasonable effort to maintain exposures to radiation as far below the federal dose limits as is practical consistent with the purpose for which the activity is undertaken, taking into account the state of technology, the economics of improvements in relation to the state of technology,

	the economics of improvements in relation to benefiting the public health and safety, and other societal and socioeconomic considerations.
Musculoskeletal Disorder	A musculoskeletal disorder is a condition where a part of musculoskeletal system is injured over time.
Parallax	Parallax refers to the apparent change in the relative positions of objects depending on the position of the viewer.
Risk Factors	Job attributes or exposures that increase probability of the occurrence of work-related musculoskeletal disorders (MSDs).
Workstation Envelope	A workstation envelope is the separation between the interior and the exterior environments of a workstation.

6.0 INTRODUCTION

According to NUREG-0711 (Reference [1]), a design-specific HFE design guidance (style guide) is developed to utilize HFE guidance in the design of the HSI features, layout, and environment. NUREG-0700 (Reference [2]), provides HFE guidelines that address the physical and functional characteristics of HSIs. These guidelines were used to create this LCS Style Guide. Use of this guide provides standardization and consistency in applying HFE principles to the design of the U.S. EPR.

This guide provides the HFE guidelines to be used on the U.S. EPR project. It is revised as additional information becomes available during the detailed design process.

7.0 HUMAN CHARACTERISTICS

7.1 Assumptions

All HFE guidelines outlined in this document take into account the physical characteristic requirements of plant personnel which are documented in the Concept of Operations document (Reference [3]). It is assumed that all operators have

- Limited mobility impairments
- Limited perceptual deficiencies
- Strength and dexterity within normal abilities
- The ability to hear alarms and conversations at a normal voice level
- The ability to read text and assess displayed values from the directed viewing distances (wearing corrective lenses, if required).
- Adequate color discrimination abilities to read the displays and differentiate between the various colors used for status, alarm, or media mimic line coding.

The current staffing guidance for the U.S. EPR is found in the Initial Staffing Assumptions for the U.S. EPR, (Reference [4]). Staffing and qualifications is developed as additional information becomes available during the detailed design process.

8.0 LOCAL CONTROL STATIONS

A local control station (LCS) is a place outside of the operation and control centers where operators interact with the plant. Local control stations may include multifunction workstations and panels, as well as operator interfaces, such as controls (e.g., valves, switches, and breakers) and displays (e.g., meters and VDUs). They have many characteristics in common with the MCR. However, they may also have unique characteristics when located in environments that are not as controlled as the MCR. For example, LCSs may have higher levels of background noise and more demanding conditions for use than the MCR. Accordingly, they may have a diverse range of communication media, such as loudspeakers, public address/pager stations, and two-way communication systems (e.g., telephones and portable wireless communications), (Reference [5]).

Local control stations allow operators to perform complex evolutions such as system lineups, start-up, shutdown, and troubleshooting of components, systems or subsystems. This decreases the distractions for the MCR operators and allows operators to maintain the appropriate level of situational awareness. Communication between LCS operators and the MCR is required prior to manipulation of plant equipment with the exception of immediate actions taken in response to alarms or obvious faulted conditions for asset protection purposes (Reference [1]).

This HFE style guide addresses LCS design using the same human factors engineering methods, standards, guidelines and principles as the MCR. This guide provides a consistent approach for appropriate labeling, indication, control, communication and environment for LCS design in the U.S. EPR.

8.1 Background

Human Factors engineering deficiencies at LCSs in existing plants have been determined to increase the potential for operator errors that could be detrimental to plant and public safety (Reference [6]). The contributing factors may include inadequate lighting, poor labeling, inadequate indication and inaccessibility.

A review of industry literature performed for NUREG/CR-6146 (Reference [5]) identified three LCS-related issues: actions performed on the wrong unit, train, or component; inadequate indication of the position of manual valves; and maintainability.

- Contributing factors identified for actions performed on the wrong unit, train, or component were labeling, layout/equipment design, communications, and environmental factors such as high temperature and cramped surroundings.

- Incorrect assessment of the position of manual valves can be a result of deficiencies in its design, such as unusual or awkward orientation of the valve, faulty assembly of the position indicator, or a handwheel which operates contrary to convention.

- Areas of concern for maintainability were poor labeling of equipment, lack of coding to differentiate components, inaccessibility of components, hostile environments, or inadequate communications systems coverage.

The contributing factors to deficiencies and issues related to poor LCS design are addressed in this guide.

9.0 LABELING

Controls, displays, and other items that must be located, identified, or manipulated shall be appropriately and clearly labeled to permit rapid and accurate user performance.

Labeling includes plant ID codes and descriptive indication (providing function-oriented information where practical) using consistent and approved abbreviations and acronyms.

The plant identification system described in the "US EPR ECS Coding Standard" (Reference [7]) is used to uniquely identify systems, equipment and components in the plant. For every item assigned a plant ID code, a unique text description composed of 20 characters or less is assigned.

See NUREG-0700 (Reference [2]) for reference to the labeling requirements listed below. Labeling for displays can be referenced in the HSI Design Style Guide (Reference [8]).

9.1 Placement of Labels

9.1.1 Labeling of Equipment

Labels shall appear on all components and systems with which personnel may interact.

9.1.2 Replacement of Labels

When labels are affixed, earlier markings (such as labels applied during construction or acceptance, or informal labels) shall be removed. Earlier markings shall not be removed until label content is verified.

9.1.3 Viewing Direction

When equipment may be approached from more than one direction, labels are placed on surfaces so that they are visible from each direction.

9.1.4 Label Visibility

Identifying labels are placed so that they are readily visible at typical viewing distances and orientations. Labels are placed so as to be visible to plant personnel of both short and tall stature.

9.1.5 Locator Labels

Readily visible markings are placed nearby to indicate the location and identity of components that are partially blocked from view. The location of overhead valves can be indicated by labels on floors or walls directly below them.

9.1.6 Label Orientation

Labels are designed and mounted so that text is oriented horizontally for ease of reading. Requiring operators to manipulate and re-orient the label is inconvenient and may lead to misreading.

9.1.7 Label Positioning

Labels shall be attached or positioned so as to unambiguously indicate the item being identified.

9.1.8 Redundant Labels

When labels are placed on the doors of equipment cabinets, redundant labels are placed inside so that they are visible when the door is open.

9.1.9 Label Placement Conventions

Specific conventions for label placement are employed for each type of equipment (e.g. valves, motors).

9.1.10 Label Mounting

Tags shall be attached to components so as not to cause damage or interfere with operation. Valve labels are not connected to handwheels or operating chains. The wire used to attach a label to a valve is passed through the yoke in a manner that does not damage the stem. For chain-operated valves, the label is wired to a small piece of plastic pipe through which the operating chain passes freely.

9.1.11 Means of Label Attachment

Labels and tags are securely attached in a manner appropriate to the equipment and environmental conditions. The method chosen to attach a label takes into account the possibility of exposure to heat, corrosive substances, oil, or solvents.

9.2 Label Design

9.2.1 Label Material

The material from which labels and tags are made is appropriate to the equipment and environmental conditions. The material chosen takes into account the possibility of exposure to heat, corrosive substances, oil, radiation, or solvents. A single label material may not be appropriate in all environments. If different label material is required at different locations in the plant, an effort is made to keep the content and format of the labels constant.

9.2.2 Label Contrast

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[ ]

9.2.3 Character Height

[ ]

[ ]

9.2.4 Stenciled Labels

Stenciled labels are not used.

9.2.5 Labeled Reflectance

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9.3 Label content

9.3.1 Label Information

[ ]

9.3.2 Labeling Conventions

Labeling conventions are employed to ensure consistency of plant labeling with drawings and procedures.

9.3.3 Standard Label Format

The format of presentation (e.g. order, position) of information is consistent on all labels.

9.3.4 Abbreviations

Abbreviations used on labels are standardized and easily recognized.

10.0 INDICATION

Indication pertains to the quality of meters and gauges or of elements of components (e.g. valves, breakers) that reflect their state (i.e. open/close). See NUREG-0700 (Reference [2]) for reference to the indication requirements listed below.

10.1 Gauges / Meters

The design of gauges and meters conforms to the relevant portions of NUREG-0700, Section 1.6.4 (Reference [2]).

10.2 PICS display

Indication on the PICS displays can be referenced in the HSI Design Style Guide (Reference [8]).

10.3 Valve Position Indication

10.3.1 Alignment Marks

Alignment marks are used to indicate open, closed and intermediate status of important manual valves.

10.3.2 Visibility of Position Indication

The location and size of the alignment marks reflect the normal viewing distance, location and ambient lighting.

10.3.3 Indication of Full Open/Closed Positions

Alignment marks show both the valve's fully open and fully closed positions.

10.3.4 Design of Position Indication

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10.3.5 Indication of Direction of Rotation

The direction of rotation for opening and closing of a valve control wheel shall be indicated in cases where the direction is not obvious.

10.3.6 Precision of Indication

Alignment marks are precise enough that the observers can tell when a valve is fully opened or closed.

10.3.7 Alternate Means of Local Position Indication

Indicators that are activated by valve limit controls are used when alignment marks would not be appropriate.

11.0 CONTROL

Control refers to the operation (as opposed to the identification or status) of equipment. See NUREG-0700 (Reference [2]) for reference to the control requirements listed below.

11.1 Design of Controls

The design and operation of controls conform to the relevant portions of Section 3, NUREG-0700 (Reference [2]).

11.2 Inadvertent Activation

Controls are protected against inadvertent actuation. The danger of inadvertent actuation of controls may be greater outside the MCR and RSS due to ongoing construction, maintenance, calibration, and outage-related activities. Controls can be affected by personnel or equipment moving by, radio transmissions, or vibration.

11.3 Suitability for Use

When necessary, the operation of controls is compatible with the use of protective clothing (PPE). The likelihood of operators requiring protection (e.g. heat or radiation) is greater outside the MCR and RSS.

11.4 Black Box

[ ]

11.5 Manual Valves

Manual valves and manual control valves sometimes need to be realigned for maintenance, testing or calibration. Pre-accident or latent human errors can occur as a result of these valves being left in the wrong position (failure to realign). This can result in the unavailability of associated safety equipment. Different methods of analysis are performed for the Human Reliability Analysis (HRA) to reduce or eliminate the human error which results in manual valves or manual control valves being left in the wrong position.

11.5.1 Operating Labels

Handwheels are provided with double-ended arrows showing the direction of operations and labeled at each end to indicate the functional result (i.e. open and close)

11.5.2 Turning Aids

Knurling, indentation, high-friction covering, or a combination of these is built into the handwheel to allow the application of the required torque.

11.5.3 Extended Valve Control

Extended valve controls that penetrate shielding walls can minimize radiation exposure. These manual controls are properly labeled to ensure the correct equipment is operated. Indication is provided to ensure correct operation on valve with extended control.

12.0 COMMUNICATION

The Communication System provides reliable and effective communications inside buildings (intra-plant), between buildings (inter-plant), and with external (plant-to-offsite) locations during normal operation, maintenance, transient, fire, accident conditions including loss of offsite power (LOOP) and security related events.

The Communication System consists of the following subsystems:

- Public Address and Alarm System
- Portable Wireless Communication System
- Digital Telephone System
- Sound Powered System
- Offsite Communication Interface System

Each subsystem provides an independent mode of communications. A failure of one subsystem does not affect the capability to communicate via the other subsystem. All of these diverse communications systems are independent of each other to assure effective communications, including any provisions to accommodate usage in areas exposed to high ambient noise in the plant.

See NUREG-0700 (Reference [2]) for reference to the communication requirements listed below.

12.1 Loudspeakers

12.1.1 Range of Coverage of Loudspeakers

Loudspeaker coverage is such that members of the work force can be alerted under all plant conditions.

12.1.2 Coverage Areas of Loudspeakers

Loudspeaker coverage is provided in all areas where the work force may be.

12.1.3 Locations and Amplitudes of Loudspeakers

Speakers are placed within a space so that their number, location, and volume provide an intelligible signal to all workers therein. Room size and configuration, and ambient noise levels are taken into account.

12.1.4 Echoes

[ ]

12.2 Public Address / Pager Stations

12.2.1 Locations of Page Stations

Page stations are located so that time required for access by personnel does not exceed 30 seconds.

12.2.2 Shielding of Page Stations

Acoustic booths or hoods are provided where ambient noise levels exceed 90 dB(A).

12.2.3 Variable Amplitude Speakers

A means of varying speaker amplitudes is provided when ambient noise levels may vary by more than 20dB. Features are provided to allow the volume setting to be monitored.

12.3 High Noise Areas

12.3.1 High Noise Environments

In areas of the plant that are subject to high-ambient noise conditions, headsets with noise-attenuating double ear cups and dynamic noise-canceling microphones (including boom or noise-shielded microphones) and/or acoustic booths/hoods are made available to plant personnel.

12.3.2 Portable Alerting Devices

Capability for personal page devices is made available and is suitable for high-noise or remote areas.

12.4 Two-way Communication Systems

12.4.1 Capacity Requirements

A minimum of five communication channels are provided to avoid excessive waiting for a free channel.

12.4.2 Dedicated Emergency Circuits

Dedicated lines are provided for frequent or emergency communications.

12.4.3 Signal Characteristics

The signal transmission characteristics of the system support good intelligibility.

12.4.4 System Access Locations

Communication system stations are located so that time and effort required for access by personnel is not excessive and so that stations are in areas of relative quiet.

12.4.5 Portable Wireless Communication Devices

Portable wireless communication systems are available to supplement installed systems. These communication systems are comprised of UHF/VHF radio transmitters/receivers, antennas, amplifiers and radio base station equipment.

12.4.6 Radio Coverage

Antennas and amplifiers are distributed throughout the plant to enable seamless radio coverage.

12.4.7 Use with Personal Protective Equipment

Communication capability is provided for personnel wearing PPE.

13.0 ENVIRONMENT

Environment includes issues of normal and emergency lighting, noise, temperature and humidity, physical access to equipment and radiation exposure. See NUREG-0700 (Reference [2]) for reference to the environment requirements listed below.

These requirements are referenced for HFE concerns only, equipment qualification evaluations for equipment housed in harsh environments are developed for supplementary documents such as the U.S. EPR Summary of Radiological Input for Equipment Qualification, (Reference [10]).

13.1 Workstation Envelope

Workstation envelope systems are implemented where an operator needs additional time to operate or monitor equipment in a hazardous or extreme environment. Envelope systems are developed to reduce cold / heat exposure, radiation exposure, or to limit noise exposure in the workspace. Some environments where envelope systems are implemented:

- Exterior or interior systems to protect against extreme cold / heat.
- Suitable shielding or ventilation systems for radiation protection, (Reference [11])
- Communication booths or hoods in high noise environments
- Sound-attenuating enclosures to protect operators working in high noise environments

- Personnel shelters to protect against inclement weather

Other human factors are monitored to ensure operability of equipment, i.e. accessibility

13.2 Radiation

Local control stations are positioned in such a way to reduce exposure to radiation hazards. Some skid mounted systems may be exposed to high levels of radiation during different plant situations. These systems can have control and instrumentation capability be placed in low radiation areas outside of the system cubicles. Placement of instrumentation and control and shielding configurations can be referenced in the EPR ALARA Design Guide (Reference [11]).

13.2.1 Instrumentation

Installing instrumentation such as audio or video equipment or mirrors to facilitate observation to perform the inspection duties required with minimum entry to high radiation areas is implemented where practical. Where conditions force instrumentation readouts to be installed in radiation areas, this instrumentation is designed for quick and accurate reading. Shielded viewing ports and oversize equipment tags are used for quick identification.

13.2.2 Control

Valve operators such as chains and reach rods are used according to the EPR ALARA Design Guide, (Reference [11]). Reach rod use is minimized as gear boxes are hard to turn and result in maintenance problems. To the extent possible, reach rods are designed in direct line with valves. Where conditions force controls to be installed in radiation areas, these controls are simple and obvious. Manual valve use is limited in high radiation areas.

13.3 Heat

13.3.1 Heat Stress

The level of physical activity and required PPE, as well as temperature and humidity, are considered when assessing the danger of heat exposure. Important considerations are the amount of metabolic heat being generated by the worker and the restriction of evaporative heat loss associated with PPE.

13.3.2 Engineering Controls

Engineering controls are applied where heat may impair the effectiveness or threaten the well being of workers. Examples of engineering controls include: shielding or insulating sources of radiant heat, eliminating steam leaks, increasing ventilation, and providing assists to reduce the strenuousness of the task.

13.3.3 Work Practices

Work practices minimize risk due to heat exposure that cannot be eliminated by engineering controls. Work practices include training in the recognition and treatment of heat illnesses, water and salt replacement, wearing of ice vests, acclimation, and work/rest cycles (stay times).

13.3.4 Water Replacement

Water is readily available in areas where the potential for heat stress exists. Unusual measures may be necessary to provide drink to workers in restricted areas.

13.4 Cold

13.4.1 Outdoor Equipment

Equipment located outdoors is sheltered from the elements as much as possible. Components subject to freezing can create maintenance and operating problems.

13.4.2 Wind Chill

When considering the effects of cold on performance, the effect of air velocity is taken into account. Table 13-1 illustrates the wind chill effect; effective temperatures are shown for different combinations of air temperature and wind speed.

Table 13-1: Wind Chill (Reference [2])

Wind Speed	Actual Air Temperature (°F)									
(mph)	50	40	30	20	10	0	-10	-20	-30	-40
Calm	50	40	30	20	10	0	-10	-20	-30	-40
5	48	36	27	17	-5	-5	-15	-25	-35	-46
10	40	29	18	5	-8	-20	-30	-43	-55	-68
15	35	23	10	-5	-18	-29	-42	-55	-70	-83
20	32	18	4	-10	-23	-34	-50	-64	-79	-94
25	30	15	-1	-15	-28	-38	-55	-72	-88	-105
30	28	13	-5	-18	-33	-44	-60	-76	-92	-109
35	27	11	-6	-20	-35	-48	-65	-80	-96	-113
40	26	10	-7	-21	-37	-52	-68	-83	-100	-117
45	25	9	-8	-22	-39	-54	-70	-86	-103	-120
50	25	8	-9	-23	-40	-55	-72	-88	-105	-123

13.4.3 Engineering Controls

Engineering controls are applied where cold may impair the effectiveness or threaten the well being of workers. Engineering controls increase the amount of heat received by the worker or insulate the worker from the cold; examples include providing space heaters or wind breaks, and insulating tool handles or valve handwheels. In addition, equipment handles and latches and panel switches and pushbuttons are operable with gloved hands where workers may be exposed to cold.

13.5 Noise

13.5.1 Quieting the Work Process

Steps are taken to reduce noise at its source. The preferred approach for mitigating the effects of noise is to reduce the vibration that is causing the noise by isolating or dampening the vibration with machine mountings. The speed of the operating machinery can be altered, thereby changing the frequency of the noise. The resonance of the vibrating objects can be reduced.

13.5.2 Limiting Noise Transmission

Steps are taken to limit the transmission of noise. Noise can be reduced by increasing the distance of the noise source from the worker. This technique is less effective for low frequencies. Sound-attenuating barriers or enclosures are used where workers are required to work near equipment that, despite quieting measures, produces high levels of noise. Sound-absorbing materials can absorb 70% of the noise that strikes them. These materials are effective for both low and high frequencies.

13.5.3 Sound Attenuating Enclosures

Space permitting, when workers are required to remain in high noise areas for extended periods of time, appropriate sound attenuating enclosures are provided.

13.5.4 Communications and Hearing Protection

Communication equipment in high noise areas is compatible with ear protection devices, (Reference [11]).

14.0 LIGHTING

14.1 Illumination Levels

Illumination levels conform to those listed in Table 14-1. This table is revised as additional information becomes available during the detailed design process.

Table 14-1: Nominal Illumination Levels

[ ]

14.2 Portable Lighting

Easily used, portable lighting devices are readily available nearby when permanent lighting (normal or emergency) may be inadequate. When temporary portable lighting is used, procedures include a reminder to remove the lighting from workspaces.

15.0 ACCESSIBILITY

Plant equipment is designed to be maintained in place, if possible, with minimum disassembly of surrounding equipment and minimum usage of temporary scaffolding and handling equipment. Permanent maintenance platforms are located where required to ensure safety and efficiency. Plant building arrangements, piping routing, and cable tray locations are designed for maximum equipment accessibility and to allow the following types of access:

- Space is provided to allow plant personnel easy access to all equipment which may require maintenance.
- Space is provided to give unobstructed access for maintenance tools and equipment required for maintenance on permanently installed equipment.
- Ample space is provided to facilitate removal of any equipment that cannot be maintained in place or that may require replacement.

To the extent practical, all equipment that requires operator manipulation, including valves, switches, inspection ports and dampers, are located so that the operator can manipulate the equipment from a standing position without obstruction and without having to climb ladders or having to climb on top of equipment.

Locate equipment with enough space for maintenance/operation, ease of accessibility, be able to bring in tools and equipment for maintenance/operation, or to disassemble the equipment (if necessary). Where possible, locate work so the worker can stand upright to get at it. They do not need to climb on top of cable trays, equipment, or piping to reach the equipment (Reference [12]).

15.1 Permanent Means of Access

Permanent means of access to equipment requiring recurrent or emergency operation are provided when it is beyond the normal standing reach of workers. Examples of access provisions include work platforms and ladders.

15.2 Temporary Means of Access

Temporary or movable access platforms to equipment are available when the equipment is located beyond the normal standing reach of workers and permanent access provision is not feasible.

15.3 Appropriate Means of Access

Catwalks, ladders, and other suitable means are provided for workers to reach equipment. Workers are not required to walk along pipes or to use components as "stepping stones" in order to reach equipment.

15.4 Sufficient Clearance

Sufficient clearance is provided in the vicinity of equipment in contaminated or high temperature areas to allow workers easy access despite the use of protective garments and associated gear.

15.5 Impediments to Access

Access to equipment to be operated is not impeded by structural elements. Structural elements added to the plant (e.g., seismic reinforcements) do not restrict access to equipment.

16.0 VIBRATION

16.1 Vibration Levels

High levels of vibration can have a negative effect on visual and manual performance. Engineering controls are applied to reduce vibration.

16.2 Reducing Vibration

Steps are taken to reduce vibration at its source. The preferred approach for reducing the vibration is to isolate or dampen the vibration with machine mountings.

16.3 Limiting Transmission of Vibration

Workers are isolated from vibration in shock-mounted, energy-absorbing platforms to limit transmission of vibration where excessive.

16.4 Reducing the Effects of Vibration

User interfaces are designed to reduce the disruptive effects of vibration. Modifications that minimize the effects of vibration on task performance include installing larger dials that can be read despite vibration or providing a means for workers to stabilize their limbs.

17.0 LOCAL ALARMS

System and functions controlled and monitored from local control stations have warnings or alarms in the MCR to alert operators to any problems or faults. These alarms alert the operators of actions to be taken locally.

[ ]

18.0 RISK FACTORS

Musculoskeletal disorders can be engendered by poor design for access, clearance and maintainability. These risk factors are related to specific design hazards. The most important ergonomics concept which designers understand and apply is that of risk factors. Risk factors are defined as "job attributes or exposures that increase probability of the occurrence of work-related musculoskeletal disorders (MSDs)."

It is necessary to focus on the following generic risk factors and to address the issue of work-relatedness:

- Unbalanced postures (leaning, twisting) and the need for muscular activity to support the legs and upper arms.
- Static, fatiguing postures,
- Work performed above the level of the heart,
- Work exceeding mid-range of movement of the joints, especially head, trunk, and upper limbs,
- Muscular force by small rather than large muscle groups,
- Twisted postures.

To the extent possible, the above risk factors are avoided in HFE design, (Reference [12]).

19.0 SECURITY

An overall plant access system is implemented using appropriate security technologies to control access to specific areas. Access to HSI throughout the plant is controlled with hardware, software and administrative controls. Area and HSI access is based on personal security concepts such as individual qualification and authorization, (Reference [3]).

[ ]

20.0 FIRE STATIONS

To be determined at a later date.

21.0 PERSONAL PROTECTIVE EQUIPMENT

Local Control Stations are designed to accommodate the appropriate standard PPE for the operational environment. LCS design does not rely on the use of PPE.

22.0 REFERENCES

1. NUREG-0711, "Human Factors Engineering Program Review Model," Rev. 2, February 2004.

2. NUREG-0700, "Human System Interface Design Review Guideline," Rev. 2, U.S. Nuclear Regulatory Commission (NRC), 2002.

5. NUREG/CR-6146, "Local Control Stations: Human Engineering Issues and Insights," September 1994.

6. NUREG/CR-3696, "Local Control Stations," April 1984.

12. EPRI Document 1014615, "Ergonomic Design for Fossil-Fueled Electric Power Plants," Dec. 6, 2006.