PALO VERDE
NUCLEAR GENERATING STATION

I&C Program

Classroom Lesson

I&C Program	**Date: 2/8/2012 4:56:28 PM**
LP Number: NID28L000002	**Rev Author: DANIEL R. REED**
Title: CEDMCS Description Lesson	**Technical Review:** Wagner, Robert W(Z96542) Digitally signed by Wagner, Robert W(Z96542) DN: cn=Wagner, Robert W(Z96542) Reason: I have reviewed this document Date: 2012.02.09 16:12:35 -07'00'
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INITIATING DOCUMENTS

Site Maintenance Training Program Description

REQUIRED TOPICS

None

CONTENT REFERENCES

VTD E146-00006 : ABB Electro-Mechanics Inc. ESFAS Auxiliary Relay Cabinet Assembly

VTD-E146-0008: CEDMCS Technical Manual

VTD C490-008 : Magnetic Jack CEDM Technical Manual

N001-1.01-413 : CE Setpoint Document

VTD-E146-0008 Control Element Drive Mechanism Control System (CEDMCS)

TCSAI 3047949 Problems with Reactor Vessel Head Retermination after outage

REVISION COMMENTS

Feb 08, 2012	Dan Reed	Record created Revision 01: Added EO's to discuss Reactivity, Reactor Core Internals and Human Performance Error Prevention Revision 02: Revised TO to have Mastery demonstrated by successfully passing a written exam with a score of 80% or better.

Tasks and Topics Covered

The following tasks are covered in CEDMCS Description Lesson :

Task or Topic Number*	**Task Statement**

Lesson: CEDMCS Description Lesson

SF16	Troubleshoot Control Element Assembly position channel
SF17	Troubleshoot Control Element Drive Mechanism Control System

Total task or topics: 2

TERMINAL OBJECTIVE:

1 Given the appropriate references, equipment and the CEDMCS simulator, the I&C technician will, maintain and troubleshoot CEDMCS.

Mastery will be demonstrated by successfully passing a written exam with a score of 80% or better.

1.1 State the purpose of CEDMCS and its major components to include: Power switches, Subgroup Logic Housing, Holdbus Indicator Panel, Holdbus Power Supply, RSPT Relay Interfaces, Common Logic Housing, Common Logic Relay Interface and CEA Relay Interfaces.

1.2 Demonstrate an understanding of reactivity and how CEDMCS work can affect reactivity

1.3 Describe Reactor Core Internals and how CEDMCS system and components fit within the reactor vessel

1.4 Describe the function and operation of a CEDM to include coil stack, voltages applied, withdrawal sequence, insertion sequence and discuss Prevent Event Tools and Electrical safe Work Practices that can be used to minimize human performance errors.

1.5 Describe the operation of the Reed Switch Position Transmitters (RSPTs) and their signal usage.

1.6 Given a block diagram of CEDMCS, describe the interface relationships with other plant systems and components.

1.7 Describe the function and operation of CEDMCS power switch assembly.

1.8 Given a block diagram of CEDMCS, describe the function and operation of the major circuits and components of the subgroup logic assembly.

1.9 Given a block diagram of CEDMCS, describe the function and operation of the major circuits and components of the common logic assembly.

1.10 Using the CEDMCS technical manual, system drawings and the CEDMCS simulator, locate specific equipment and identify their function within CEDMCS.

1.11 Perform a pre-job brief for the performance tasks

1.12 Using the CEDMCS simulator and all necessary equipment, calibrate the CEDMCS logic housing coil voltage.

1.13 Using the CEDMCS simulator and all necessary equipment, obtain CEA coil traces.

1.14 Using the CEDMCS simulator and all necessary equipment, including appropriate prevent event tools, troubleshoot and rework CEDMCS.

Content	**Methods and Activities**
I. Attention Step.	I. Give a brief statement or story to get students attention focused on the course subject matter.
II. Self Introduction.	II. Introduce yourself and present your back-ground and experience, if applicable. This is the best opportunity to have students introduce themselves, if you use this technique to "open up" the class.
III. Classroom Guidelines	III. Refer to the CLASS GUIDELINES at the front of the handout and in front of this lesson plan. Read them or discuss them as applicable to the particular group in your class.
A. Attendance Sheet	A. Pass the attendance sheet around and have it signed in black ink. If applicable, have students add their mail station numbers to the attendance sheet for use when mailing out course certificates. If needed, now is a good time to fill out a seating chart or individual name cards.
B. Materials	B. Ensure that student materials needed for the class are available for each student. For materials required, refer to the list materials on the cover page. Describe the handout format, if applicable, and stress the importance of taking good notes for future reference, both in the field and for the remainder of the course.
C. Questions and Participation	C. Discuss the importance of participation and your philosophy on asking or answering questions (i.e., do they need to raise their hand, etc.), if applicable.

Content	**Methods and Activities**
IV. Course Introduction Course Element Drive Mechanism Control System	IV. Give a brief statement which introduces the course topic. It may be sufficient to point out the title on the board, and should be limited to one simple statement.
V. Motivation	V. Focus the students attention on the benefits they will derive from the training.
VI. Course Pre-summary (Overview)	
A. Given the appropriate references, equipment and the CEDMCS simulator, the I&C technician will maintain and troubleshoot CEDMCS. Mastery will be demonstrated by successful completion of all lab practical evaluations.	A. Show PPT overview slides and discuss the course objective.
B. Course Outline and Sequence: 1. CEDMCS Review 2. JPM Exercises C. Assignments and Evaluations	B. Review the outline of course topics or lessons, and present a general course schedule or sequence.
VI. Lesson Introduction A. Topic Introduction B. Motivation C. Lesson Pre-summary (Overview) 1. Lesson Terminal Objective: Given the appropriate references, equipment and the CEDMCS simulator, the I&C technician will maintain and troubleshoot CEDMCS. Mastery will be demonstrated by successful completion of all lab practical evaluations. 2. Topic Summary a. CEDMCS Review b. Lab Exercises	1. Course overview PPT. Read and discuss the lesson terminal objective, and review the lesson enabling objectives.

TO: 1	**Given the appropriate references, equipment and the CEDMCS simulator, the I&C technician will, maintain and troubleshoot CEDMCS.** **Mastery will be demonstrated by successfully passing a written exam with a score of 80% or better.**

EO: 1.1 State the purpose of CEDMCS and its major components to include: Power switches, Subgroup Logic Housing, Holdbus Indicator Panel, Holdbus Power Supply, RSPT Relay Interfaces, Common Logic Housing, Common Logic Relay Interface and CEA Relay Interfaces.

Content	Methods and Activities
Introduction	
CEDMCS is a huge and complex system with many inputs and outputs. It can control CEAs individually, in subgroups, in groups and multiple groups at a time. It must respond to demands and logic signals from multiple systems, and provide many and various outputs to other plant systems.	Show Title powerpoint slide & course overview slide. Show PPT slide series 'Prevent Events'
Some jumping around in the Powerpoints and lesson plan is inevitable. The Powerpoint presentation at many places does not exactly follow the objectives, but provides additional information to enhance student understanding of the system. However, all the material in the lesson plan is covered in the slide presentation.	
I. Control Element Drive Mechanism Control System (CEDMCS) Overview A. Purpose of the CEDMCS	A. Display PPT slide 'Terminal Objective' & 'Enabling Objectives' and discuss the purpose of CEDMCS.
1. Purpose of CEDMCS is to provide drive signals to the CEDM's in response to automatic or manual demands. 2. CEDMCS also provides the CEDM coil voltage necessary to hold up the CEA's and prevent them from gravity inserting into the core.	Show PPT 'CEDMCS Overview and Block Diagram' slide
B. Control Element Assembly (CEA) arrangement 1. CE System 80 reactor design uses 89 neutron absorbing CEA's. 2. Provides control of neutron flux levels. 3. Spread symmetrically throughout the core. 4. The three types of CEA's, shutdown, regulating and power shaping are broken down into nine control groups.	B. Display CEDMCS Overview and Core Map PPT slide and discuss CEA arrangement. • PPT slide CEDMCS Overview • Draw groups and subgroups on board for later reference many times in the class. • Note: the system is capable of handling up to 8 reg groups.
a. Shutdown A.	4 subgroups, 16 CEAs all 12 finger
b. Shutdown B.	5 subgroups, 20 CEAs, all 12
c. Regulating 1. d. Regulating 2. e. Regulating 3. f. Regulating 4. g. Regulating 5. h. Power Shaping P1.	

Content	**Methods and Activities**
i. Power Shaping P2.	finger
5. Control groups are further broken down into subgroups of 4 CEAs each (except for power shaping subgroup 8, which has 5).	2 subgroups, 8 CEAs all 12 fingers
a. Control groups may have as many as 5 subgroups or as few as 1.	2 subgroups, 8 CEAs all 4 fingers
	3 subgroups, 12 CEAs, mixed 12 and 4 finger group
	2 subgroups, 8 CEAs all 4 fingers
	1 subgroup, 4 CEAs all 4 finger
	1 subgroup with 5 CEAs, all 4 finger
	2 subgroups, 8 CEAs, all 4 finger
C. Control Element Drive Mechanisms (CEDM's).	Show PPT slide 'CEDM Cutaway'
1. Each CEA is equipped with a magnetic jack assy. to move the CEA on demand.	89 jack assemblies total
2. Magnetic jack has 2 mechanical grippers (upper and lower) to engage notches in CEA extension shaft to transmit CEA motion and to prevent gravity insertion.	Show PPT slide 'Coil Stack' & 'Insert & Withdraw Sequence'
3. Four DC magnetic coils are selectively energized to engage the grippers so motion can be transmitted.	
D. Modes of Operation	Show PPT slide series 'Modes of Operation'
The CEDMCS can either be operated manually from the CEDMCS operators console or automatically from the Reactor Reg. System. Specifically the modes of operation are:	
1. Automatic Sequential (AS).	Reg Groups only
2. Manual Sequential (MS).	Reg Groups Only
3. Manual Group (MG).	Any Group
4. Manual Individual (MI).	Any one CEA
5. Standby.	Used to be called 'Off'
E. Design Basis.	Show PPT slide series 'Design Basis'
The following design criteria are applicable to the CEDMCS.	What we need the system to do
1. Provide proper DC voltages to move and maintain CEA position.	UGS, LGS, UEL, LEL, AMI, AWP, CWP, RPCS
2. Ensure no more than 3/4" (one step) deviation between subgroups with a control group.	
3. In MG, MS or AS modes all CEA's within a subgroup must be moved	

Content	**Methods and Activities**
together. 4. Allow single CEA movement in the MI mode. 5. Ensure proper response to system interlocks and CEA motion limit signals. 6. Provide local/remote indications and alarms. 7. Provide a redundant hold bus power supply assy. to allow maintenance of a subgroup logic or power switch assy. 8. Allow sequential overlap motion of regulating groups.	
F. CEDMCS Functional Overview.	Display PPT slide 'CEDM Block Diagram' slide. Review the overall function layout of the CEDMCS
CEDMCS mode is selected at the operator's module. Demand signals are generated either at the operator's module or the RRS. The logic determining CEDM motion is composed of the following: 1. Common Logic Relay Interface. Purpose is to provide a relay interface for common logic subgroup logic and hold bus. 2. Common Logic Purpose is to: a. Receive demand logic and interlocks from the relay interfaces to: (1) Synchronize CEA, subgroup and group motion. (2) Ensures compatibility of mode and group selection. b. Provides system timing requirements. c. Transfers raise or lower commands to the appropriate subgroup(s). d. Provides reset and alarm functions. 3. Subgroup Logic Purpose is to: a. Control the firing angle of its' assigned power switch SCRs. b. Control the actuating sequence of the four CEDM coils for each CEA. c. During MI Mode, the subgroup logic decodes the CEA selection and enables the circuits necessary to move the CEA. 4. Power Switch Assemblies. Purpose is to take trigger pulses from the subgroup logic and use them to control the firing angles of the SCRs which provide the DC coil voltages to the CEDM coil stacks. 5. CEA #1 and Hold Bus Logic Purpose is to: a. Control the firing angle of the SCR's in the hold bus power supply and in the power switch for CEA #1.	Show 'Relay Interface' PPT

Content	Methods and Activities
b. Control the actuation sequence of the four CEA coils for CEA #1. c. Allow transfer of a subgroup onto or off the hold bus power supply. d. Provide distribution of the MI mode select signal to each subgroup logic housing. 6. Hold bus indicator panel. Purpose is to provide a means of transferring subgroups to and from the hold bus power supply. 7. CEA Relay Interfaces. Purpose is to provide a relay interface for the subgroup logic and the PMS and RPCS. 8. RSPT Relay Interface. Purpose is to provide input and output interface for RSPT's, UEL, LEL and DRC contacts.	

EO: 1.2 Demonstrate an understanding of reactivity and how CEDMCS work can affect reactivity

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The I&C technician does not need to know how to calculate an estimated critical position, or determine the effective rod worth of each subgroup, but should have a basic understanding of the processes at work within the reactor and how the CEDMCS system can affect those processes. The following is an overview of reactivity and control rod impact on it.	Video: *Breaking the Chain* 1st experiment showing discovery of "extra" neutrons from Uranium fission.
A **critical mass** is the smallest amount of fissile material needed for a sustained nuclear chain reaction. The critical mass of a fissionable material depends upon its nuclear properties (e.g. the nuclear fission cross-section), its density, its shape and its enrichment.	U235 – 52kg, or a sold sphere 17cm across Pu239-10kg, or a solid sphere 9.9cm across
Discuss how we load the maximum amount of fuel into the core by addition of poisons and boron dissolved in the coolant.	Changing the point of criticality by changing the mass, density, geometry and configuration of the poisons and the fuel.
Discuss factors that affect critical mass including: Void fraction Fuel Temperature Coefficient of reactivity Moderator temperature coefficient of reactivity Leakage Poisons 1. In order to understand the control of the neutron population, we must know what happens to a neutron from the time it is born in the fission process to the time it is absorbed. **The Six Factor Formula** The effects of each process described above are quantified by defining the ***six factors*** which govern the neutron multiplication	MTC, FTC and void fraction collectively are referred to as Power Defect Cover chain reactions and neutron production

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process. Each factor is defined as a ratio of the number of neutrons after a particular process has occurred to the number of neutrons before the process occurred.	Relationship between reactivity and effective multiplication factor.
Fast Fission Factor When a neutron generation begins, a group of fast neutrons is produced by thermal fission. Some of these fast neutrons will cause fission events to occur, resulting in an increase in the fast neutron population. The ***Fast Fission Factor*** is the factor by which neutron population is ***increased*** as a result of fissions caused by fast neutrons	Glass Top Simulator: Show class effects of dropped CEA on various plant parameters; Tie back to six factor formula
Fast Nonleakage Factor As the fast neutrons in the core go through the slowing down process, some of these neutrons leak from the core. The ***Fast Nonleakage Factor*** is the factor by which nonthermal neutron population is ***decreased*** because of leakage of nonthermal neutrons from the core	
Resonance Escape Factor Some of the fast neutrons are captured by resonance absorber materials as the neutrons slow down. The ***Resonance Escape Factor*** is the factor by which neutron population is ***decreased*** because of nonproductive absorption (capture) of neutrons as they slow down.	Average Logarithmic Energy Decrement
Thermal Nonleakage Factor Some of the neutrons that reach thermal energy leak from the core. The ***Thermal Nonleakage Factor*** is the factor by which thermal neutron population is ***decreased*** because of leakage of thermal neutrons from the core.	
Thermal Utilization Factor Some of the thermal neutrons which remain in the core are absorbed by fuel materials, and some are absorbed by thermal poisons. The ***Thermal Utilization Factor*** is the factor by which neutron population is ***decreased*** because of absorption of thermal neutrons in non-fuel (thermal poison) materials.	
Reproduction Factor Most of the thermal neutrons absorbed in fuel result in fission, producing the fast neutrons which begin the next neutron generation. The ***Reproduction Factor*** is the factor by which neutron population is ***increased*** because of fission events resulting from thermal	

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neutron absorption by fuel. Net core reactivity is defined as the ***fractional change in neutron population per generation***. Specifically, reactivity is the change in neutron population, from one generation to the next, divided by the final neutron population: Reactivity: $\rho = \frac{N_1 - N_0}{N_1}$ where: N_0 = Number of neutrons which started the previous generation N_1 = Number of neutrons starting the present generation Since $K_{eff} = \frac{N_1}{N_0}$, the reactivity formula can be defined directly in terms of K_{eff}: $\rho = \frac{N_1 - N_0}{N_1} = \frac{\frac{N_1}{N_0} - \frac{N_0}{N_0}}{\frac{N_1}{N_0}} = \frac{K_{eff} - 1}{K_{eff}}$ Reactivity: $\rho = \frac{K_{eff} - 1}{K_{eff}}$ ***Note:*** In Reactor Engineering textbooks, reactivity is defined by the following formula: $\rho = \ln K_{eff}$ If K_{eff} is sufficiently close to 1,	

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$$\ln K_{eff} \approx \frac{K_{eff} - 1}{K_{eff}}$$ The nuclear industry used $(K_{eff} - 1)/K_{eff}$ for reactivity calculations. **Example A** Determine the value of reactivity if $K_{eff} = 1.003$, and give a physical interpretation to the value of reactivity.	

EO: 1.3 Describe Reactor Core Internals and how CEDMCS system and components fit within the reactor vessel

Content	Methods and Activities
III. Reactor Core Internals A. CEDM construction 1. Magnetic jack CEDM is an electro-mechanical device that uses induced magnetic fields to operate a mechanism for moving a control element assembly. The pressure housings for these mechanisms are threaded onto nozzles on the reactor vessel head and seal welded. The mechanism operates in primary coolant at reactor pressure. 2. A grooved drive shaft extends through the drive mechanism to the top of the CEA. Latches in the driving unit engage the grooves on the shaft and provide means for lifting, holding and inserting the CEA. Coils mounted in a coil stack assembly slide over the mechanism pressure housing and rest upon a located shoulder. These coils provide the magnetic flux that operates the mechanical part of the drive within the pressure housing. 3. The CEDMs are mounted on nozzles on top of the reactor vessel closure head. Each CEDM is connected to the CEA by an extension shaft with a spring locked coupling. The weight of the CEDMs and the CEAs is carried by the pressure vessel head. The CEA drop time for 90% insertion is 4.0 seconds maximum, where drop time is defined as the interval between the time power is removed from the CEDM coils and the time the CEA has reached 90% of its fully inserted position. B. Motor Assembly 1. The motor assembly is an integral unit that fits into the motor housing and provides the linear motion to the CEA. The motor assembly consists of a latch guide tube, upper latches and lower latches. 2. Both upper latches and lower latches are used to perform the stepping of the CEA and by proper sequencing perform a load transfer function and to minimize latch and extension shaft wear. The upper latch also performs the normal "hold" function when CEA motion is not required. Engagement of the extension shaft by the latches occurs when the appropriate set of magnetic coils is energized. This moves sliding magnets which are connected to a two-bar linkage mechanism and moves the latches inward. The upper latches move vertically 7/16" while the lower latches move vertically 3/8" to perform both the load transfer and stepping action. Total CEA motion per cycle is ¾	A. Display PPT slide series 'CEDM Core Internals' and explain the construction of the CEA's and CEDM's within the reactor vessel

Content	Methods and Activities
C. Coil Stack and Conduit Assembly 1. The coil stack assembly for the CEDM consists of four large DC magnet coils mounted on the outside of the motor housing assembly. The coils supply magnetic force to actuate the mechanical latches for engaging and driving the CEA extension shaft. Power for the magnetic coils is supplied from two separate supplies. The CEDMCS control system actuates the stepping cycle and obtains the correct CEA position by a forward or reverse stepping sequence. CEDM "hold" is obtained by energizing the upper latch coil at a reduced current while all other coils are de-energized. The CEAs are tripped upon interruption of electrical power to all coils. Electrical pulses from the magnetic coil power programmer provide one of the means for indicating CEA position indication. 2. A flexible conduit extends from the coil stack wiring trough to the top of the upper pressure housing shroud such that cable connection is made at the top of the CEDM. The coil stack is surrounded by a sheet metal cooling shroud producing an annulus which air can flow through. Air flowing from top to bottom of the coil stack will remove operating coil heat and some internal CEDM heat to maintain the coils at a temperature of less than 350°F. D. Extension Shaft and CEA Coupling Assembly 1. The extension shaft assemblies connect the CEDMs to the CEAs. The extension shaft assembly (approximately 280 inches long) consists primarily of a drive shaft with circumferential grooves machined along its outer diameter. The grooves, which act as rack teeth, provide a means of engagement to the CEDM. By actuating the CEDM latches in sequence, the extension shaft and attached CEA is raised or lowered as desired. Attached at the lower end of the drive shaft is the gripper. The gripper is a machined part with eight integral fingers. The fingers are free-formed to a point configuration so as to provide sufficient lead-in into the mating CEA spider hub. E. Extension Shaft Magnet Assembly 1. The collapsed fingers, once inserted into the CEA spider hub, are then expanded by a spring loaded plunger that is inserted within the fingers. This expanding action locks the extension shaft to the CEA. This spring loaded plunger exerts constant pressure on the fingers maintaining a tight (locked) joint during reactor operation. In order to break this joint, the spring loaded plunger must be withdrawn enabling the gripper fingers to collapse to their free-formed state. The plunger is withdrawn through use of the operating rod. The operating rod is a tube that runs through the center of the drive shaft and	

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connects the plunger to the magnet assembly. The operating rod is also spring loaded so as to preclude motion due to CEDM operation. The magnet assembly consists of an inner housing that is attached to the operating rod and an outer extension sleeve that is attached to the drive shaft. There are two “J” slots machined in the upper end of the housing and the extension sleeve that allows engagement with the gripper operating tool. 2. By using the gripper operating tool to move the inner housing relative to the outer extension sleeve, the plunger is withdrawn from the gripper fingers allowing the fingers to collapse. The gripper operating tool is used in this fashion to couple/uncouple extension shafts to/from their CEAs. 3. The magnet assembly which comprises the top of the extension shaft assembly, consists of a housing containing two 2" cylindrical permanent magnets separated by a 1/2" carbon steel spacer. The magnet field produced is of sufficient intensity to actuate adjacent reed switches contained in the reed switch position transmitter (RSPT). Displacement of the magnet progressively actuates and de-actuates the switches, thereby producing RSPT signal voltages proportional to the CEA position. The magnet assembly extension sleeve also has a circumferential groove machined in it. The groove provides a means of engagement with the CEA/extension shaft latching mechanism that is used to withdraw the extension shaft and its attached CEA from the core during refueling operations.	

EO: 1.4 **Describe the function and operation of a CEDM to include coil stack, voltages applied, withdrawal sequence, insertion sequence and discuss Prevent Event Tools and Electrical safe Work Practices that can be used to minimize human performance errors.**

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II. Control Element Drive Mechanisms (CEDMs)

The 89 CEDMs are electromagnetic devices which use induced magnetic fields for moving CEAs. They are located at the Reactor Vessel head.

A. Construction

1. Threaded and Seal welded CEDM housing is RCS pressure boundary.
2. Drive Mechanism
   a. Latch mechanisms (upper and lower) engage grooves on the drive shafts to transmit motion and to hold the CEA up.
   b. A permanent DC magnet on top of the extension shaft is used to activate read switches on the RSPT's.
3. Four CEDM coils are arranged in a coil stack which is slipped over the upper pressure housing. They are:
   a. Upper Lift coil (UL).
   b. Upper Gripper coil (UG).
   c. Lower Lift coil (LL).
   d. Lower Gripper coil (LG).

B. Magnetic Jack Operation

Withdrawal, insertion, or holding the CEA is accomplished by programming current to the various coils. There are three programmed voltages for the coils: high for initial gap closure, low for maintaining the gap closed, and zero to allow opening the gap.

1. Operating Sequence
   a. Hold
      (1) Initial condition
      (2) Upper latch at low voltage
   b. Withdrawal Sequence
   c. Insertion Sequence
2. Scramming

Scram or rapid insertion of the CEA assembly occurs when the magnetic jack coils are deenergized allowing the latches to be disengaged from the drive shaft. The drive shaft is released and the CEA falls, due to gravity to the fully inserted position.

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A. Display PPT slide 'CEDM Cutaway' and review the physical construction of a CEDM.

Show 'Insert & Withdraw' PPT slides

Show 'Coil Voltage Timing Chart' PPT slides

b. Display 'Coil Trace' PPTs explain the withdrawal operating sequence of the CEDMS during hold, withdrawal and insertion.

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EO: 1.5 Describe the operation of the Reed Switch Position Transmitters (RSPTs) and their signal usage.

III. Control Element Position Measurement A. RSPT's 1. Two RSPT's are mounted exterior to the pressure housing, above each CEDM. 2. Each RSPT consists of a group of reed switches and a voltage divider located in a stainless steel tube. 3. Two reed switches are wired in series and located every 1/2". 4. Reed switches are activated by a permanent magnet mounted on top of the extension shaft to indicate CEA position. 5. RSPT power supplies, located in the Aux. protection cabinets, provide a fixed 15 VDC to each RSPT. 6. The voltage divider is arranged such that the output is 5-10 VDC for a CEA travel of 0-150". This position signal is then outputted to: a. Core Protection calculators (CPC's) (4). b. CEA calculators (CEA's) (2). c. CEA position isolation amplifiers (CPIA's) (2). 7. One of the two RSPT's on each CEDM is called a Type 2 RSPT and has 3 additional contacts. Type 2 RSPT's have 9 output leads instead of 3 output leads. a. Upper Electrical Limit (UEL). b. Lower electrical Limit (LEL). c. Dropped Rod Contact (DRC). 8. These contacts feed the Digital Isolation Device Assemblies (DIDA's), to provide 1E/Non 1E isolation before going to CEDMCS.	A. Display PPT slide series 'RSPT' and explain the construction and operation of type 1 and 2 RSPT's.
B. CEA Calculators (CEAC's) 1. CEAC's are mini-computers. There are two redundant trains. Each look at all 89 CEA positions. 2. CEAC outputs a. Each supply CRT main control board CEA positions. (RMN-B04). b. Each supply penalty factors to all four CPC trains.	B. Display PPT Slide Series 'RSPT' and discuss the function of the CEAC's and how RSPT outputs are used by the CEAC's. Show CEAPDS PPT slide
C. Core Protection Calculators (CPC's) 1. CPC's are mini-computers used to make the following calculations: a. Departure from Nucleate Boiling Ratio (DNBR). b. Local Power Density (LPD). 2. The results are fed to the Plant Protection System.	

3. CPC's use CEA position info two ways. a. Each CPC addresses 22 target CEA's (one core quadrant) to calculate radial peaking factor and core axial power distribution. b. Each CPC looks at both CEAC outputs, which are penalty factors from all 89 CEA positions.	
D. CEA Position Isolation Amplifiers (CPIA). Isolation amplifiers that provide isolation between safety trains for the 22 target CEAs that would be common to CEAC #1 and CPC channel A, and CEAC #2 and CPC channel D.	D. Discuss the function of the CEA Position Isolation Amplifiers.
E. New CPCs – Discuss differences between old and new CPCs Fiber optic Redundancy New screen displays New Core Element Assembly Parameter Display System (CEAPDS) Operating Event DFWO 3118045 Unit 3 CEA 3 LEL and DRC indication Anomalies On 1/4/08, during coil voltage adjustments and CEA testing for CEA 3 in Unit 3, the Lower Electrical Limit (LEL) and Rod Drop Contact (DRC) lights were observed to be energized, then to de-energized, then to re-reenergized, then to de-energized a second time during the first few inches of withdrawal of CEA 3. Similar erroneous indications were observed when the CEA was inserted to a position near the fully inserted position. The condition was very repeatable and occurred in both the insert and withdraw directions. I&C Maintenance Engineering believes that the LEL and DRC reed switches in RSPT 3JSFCZT0003B are degraded and susceptible to interference from magnetic fields from adjacent CEA coils. However, the RSPT (LEL and DRC contacts) does function normally in the fully inserted position and there is no evidence of a problem with the reed switches for the analog position signal. In order to restore the equipment to its normal condition, the RSPT will be replaced during 3R14. Replacement during 3R14 is recommended since the reactor head must de-stacked to replace the RSPT.	E. Show PPT slides of new CPC screen shots. Have students read OE in OE handout

EO: 1.6 Given a block diagram of CEDMCS, describe the interface relationships with other plant systems and components.

Content	Methods and Activities
IV. Inputs/Outputs of the CEDMCS	
A. CEDMCS inputs	1. Display Powerpoint Slide show 'Inputs and Outputs' and discuss CEDMCS power supplies and distribution.
1. Power Supply inputs	(1) Draw connection from MG sets thru Rx trip brkrs to CEDMCS
a. 240 VAC CEDM drive power. (1) Developed by 2 Motor-Generator sets. (2) Power "laddered" through two lines.	(a) 'A & B' breakers
(a) Four GE Rx trip breakers.	(b) 'C & D' breakers – tell story of old trip breakers and why they were replaced
(b) Two Westinghouse Rx trip breakers replaces with GE breakers (3) Feed CEDMCS cabinets at Cab. C1 and C3.	
b. Instrument logic, relay and lamp power comes from plant 120 VAC instrument buses.	2. Display PPT Slide series 'Operator Interface' and review the controls and indications of the operator interface.
2. Operator Interface	
a. Located on main control room panel RMN-B04 (right hand side).	
b. Controls	
(1) Mode select.	
(2) Group selection. (3) PS group selection. (4) Individual CEA select. (5) Joy stick.	

Content	Methods and Activities
(6) CWP Bypass switch.	
c. Indications (1) Mode Select. (2) Group Indication. (3) Withdraw/Insert Indication. (4) UEL Indication. (5) LEL Indication. (6) CEA Indicator. (7) CWP Bypass.	c. Display PPT slide series 'Operator Interface' and review the indications.
3. Signal inputs a. RCS Tcold #1 and #2. b. Steam Bypass Control System AWP, AMI.	3. Display PPT slide series 'Inputs and Outputs' and direct/introduce students to prints N001-13.02-591 to 599 (38010 shts. 1-9) CEDMCS block diagrams • Automatic Withdraw Prohibit (AWP) • Prohibits the withdrawal of all Reg. Group CEAs in the Auto-Sequential Mode • Generated by CEDMCS whenever: o AWP from SBCS o Tavg Dev from RRS o Tc1 or Tc2 deviation from plant instrumentation • Automatic Motion Inhibit (AMI) o Prohibits withdrawal and insertion of all Regulating Group CEAs in the Auto-Sequential mode o De-energizes the AR and AL Relays
c. RRS - Auto Raise, Auto Lower Hi Rate, Tavg Dev.	AMI is only generated when like channels are in average on RRS • Auto-Raise, Auto-Lower (AR / AL) o Control the direction of Reg Group motion • Low Rate (LR) o Limits Reg Group motion to 1/10th normal

Content	Methods and Activities
	speed
d. RSPT's - LEL, UEL, and DRC contacts.	• Located in cabinet C4 Bay 4 • Receive input signals from RSPTs via CEDMCS Aux cabinets • Output signals to CEDMCS logic and display circuits and the CEA Core Mimic • Three types of signals are transferred: o Dropped CEA (DRC) o Upper Electrical Limit (UEL) o Lower Electrical Limit (LEL)
e. RPCS - Subgroups drop and sub-group(s) arm.	
f. PPS - CEA withdrawal Prohibit.	• CEA Withdrawal Prohibit (CWP) • Prohibits withdrawal of any CEA in all modes • Generated by PPS when Excore is <1% or on a high Pressurizer Pressure
g. PMS - UGS, LGS, Sequential permissive.	• Upper Group Stop & Lower Group Stop (UGS,LGS) – Determined by the plant computer – Sent to CEDMCS via relays in the CLRI • Sequential Permissive (SP) – Allows Regulating groups to be moved in AS and MS modes
4. Relay interfaces. a. RSPT.	• 3 Interfaces • Bunch of relays • Take the following contact inputs from the DIDA cabinets - Dropped CEA (DRC) - Upper Electrical Limit (UEL) - Lower Electrical Limit (LEL) • Outputs to logic, displays and core mimic

Content	Methods and Activities
b. Common Logic Relay interfaces.	• Located in C4 Bay 2 • Provides electrical isolation between CEDMCS and all external equipment • Increases signal drive capability • Provides signal interlocks • Contact multiplication
c. CEA relay interfaces.	• Provides outputs and interfaces for: – Plant Annunciator system – Plant computer (up count and down count) – RPCS • 3 housings •
B. CEDMCS outputs	B. N001-13.02-591
1. Power output.	
High and low voltage signals to the 4 coils associated with each of 89 CEDM's.	
2. Signal outputs	
a. RRS - CEDMCS in manual?	
b. PMS - Bus undervoltage, upper and lower CEA limit ML, MR, CS, MS, PLS, GS, DRC's.	
c. Operators module - Group select, Raise lower CEA, LEL, UEL, CEA select.	
d. Core mimic display - DRC contact.	
e. CEDMCS plant annunciator alarms - (RK system)	
f. Undervoltage detector outputs.	
(1) TCS - Turbine Trip.	
(2) FWCS - Rx trip override.	
(3) SBCS - Q.O.B. with low Tavg.	
(4) PPS - Reactor trip leg indication.	
3. Relay interfaces	3. This is wired through FWCS - reason why it doesn't show up on block diagram
a. Common logic relay interfaces.	
(1) Plant computer	
(2) SBCS	

Content	Methods and Activities
(3) RRS (4) PPS via AUX cabinets (DIDA) (5) Process inst. (T_c) (6) Operators module b. CEA relay interfaces. (1) Pulse counting relays (2) Subgroup maintenance (3) System annunciator relays c. UV detectors.	(2) Used for transfer to hold bus and Rx power cutback (3) LCR, SMA, SSDA, CDA, TFA, LSA, RSA, CSFA, CLF, CGHVA, CMA, & DTI **page 5-36 T/M** Question students on block diagram inputs and outputs.

EO: 1.7 Describe the function and operation of CEDMCS power switch assembly.

Content	Methods and Activities
D. Power Switch Assembly 1. There are 3 SCRs/ Coil, 4 coils/CEA, 4 CEAs/Power switch for a total of 48 SCRs 2. Each SCR has a suppression circuit consisting of a resistor and a diode. 3. A shunt is provided for each coil to allow monitoring on the front panel jack. 4. There are four opto isolator cards that isolate the subgroup logic from the 3ϕ AC power. 5. There is a Zero crossing detector that monitors all 3 phases of the AC power and generates a 100 microsecond pulse that begins 50 microseconds before the AC voltage crosses zero. 6. The high and low voltages generated by the power switch are controlled by controlling the firing time of the SCRs. a. When the SCR is fired early in the cycle, the voltage will be present longer. When the three phases are added together it results in a high voltage to the coil. b. For a low voltage the SCR is fired later in the cycle resulting in a lower voltage.	Show Powerswitch PPT For coil traces Refer to figure 5-14 on page 5-100 and 5-11 on page 5-77 And Show timing PPT slides
V. Logic and Power Operation A. Power Switch Assembly (PSA) Description The power switch assemblies accept SCR trigger pulses from their subgroup logic assemblies, isolate them, and use these pulses to fire SCRs producing the DC output to the CEDMs. The power switches also provide 3 phase reference timing to the subgroup logic assemblies. 1. PSA Construction a. Each power switch drives 4 CEDMS. b. 3 SCR's per coil, 12 per CEDM, 48 per power switch. c. 3 SCR's for a coil have their outputs tied together. d. CEA's Y1 and Y3 use positive half cycle of sine	1. Display PPT slide series 'Power Switch' and review PSA construction..

Content	Methods and Activities
wave; while Y2 and Y4 use the negative half.	
e. The trigger signals are optically isolated from the subgroup logic.	e. One optical isolator card per CEA assignment - 4 opto isolators.
f. A zero cross over detector senses the zero crossover point for each of the phases and supplies the subgroup logic assembly this information so it can stay timed with the 3 phase 240 VAC, to control the gating pulse times.	f. One zero crossover detector circuit board Draw diagram illustrating location of circuit boards in power switch assembly.
2. PSA operation	2. Display PPT slide series 'Power Switch' and review PSA operation.
a. 3 SCR's per coil use the 240VAC input to produce a pulsating DC voltage.	
b. Firing angle of the SCR determines output amplitude.	
(1) SCR fires late in sine wave for low DC voltage.	
(2) SCR fires early in sine wave for high DC voltage.	
(3) SCR does not fire for 0 DC voltage.	
(4) SCR turns off as sine wave crosses zero.	
c. Timing Sequence	c. Review the voltage timing sequence required for CEA withdrawal and insertion.
(1) Can be found in CEDM T/M (N001-13.02-139) or CE Setpoint Document (N001-1.01-413)	
(2) Different for withdrawal and insertion	**At this point keep to big picture.**
(3) Controlled by timer card settings in the subgroup logic assembly	(3) Will be covered in detail during subgroup logic assembly discussion

EO: 1.8 **Given a block diagram of CEDMCS, describe the function and operation of the major circuits and components of the subgroup logic assembly.**

B. Subgroup logic Assemblies Description The subgroup logic controls the firing angle of SCRs within assigned power switch. It controls actuating sequence of the 4 coils for each CEDM. During MI mode it decodes CEA selection and enables only the SCRs for that CEDM. 1. Subgroup logic cards (each subgroup) a. Individual CEA Enable and Pulse Count Logic Card (1 each). b. Phase Sync Pulse and CEA Selector (2 each). c. CEA Timer cards (4 each). d. Coil Driver Actuating Logic cards (2 each). e. LED Driver card (1 shared by two subgroups). 2. Card Descriptions a. Individual CEA Enable and Pulse Count Logic Card. (Catch all card for sublogic). (1) MI; define CEA selection, direction of motion for CEA timer and coil driver cards. (2) MG, MS, and AS; define motion direction for CEA timer and coil driver cards. (3) Cycle time (CT) indication to common logic ("Busy"). (4) Up and down counts to computer and totalizer. b. Phase Sync Pulse and CEA Selector Cards. (1) Accept zero crossover from power switch; produces 2 pulse trains. (a) PHA - high coil voltage (b) PLA - low coil voltage (c) PHA, PLA are continuous. Coil driver card selectively gates to energize coils. (2) Decodes BCD MI signal, enables appropriate timer card. c. Timer Cards (1) Provides timing pulses (high, low and zero voltage), for four coils of a single CEDM. (2) MI mode; set cycle time for CEDM. (3) Provide cycle time (CT) and Motion Pulse (MP) signals and sends them to the Individual CEA Enable and Pulse Count Logic card. (4) Provides a CEA timer failure alarm. (5) Latch "upper gripper hold" to coil driver card if gripper output pulse is lost. d. Coil Driver Actuating Logic Cards (1) Accepts PHA and PLA from phase synch cards;	B. Display Powerpoint slide series 'Subgroup Logic' as needed and review subgroup logic. Start by giving students just the different card functions. **Big picture.** **1. Page 3-5 in T/M illustrates card locations in bays** (c) Card 1 for UG and UL, card 2 for LG and LL. On failure

selectively gates per timing signals from timer cards to produce SCR gating pulses. (2) Latch UG hold upon timer failure. (3) Drops CEAs on Reactor Power Cutback Signal. (4) Apply UG hold on loss of primary power supply. (Auctioneered backup power supply).	On failure
e. LED Driver Circuit Provides subgroup logic statuses and alarms to front panel and alarm system.	On failure
3. Subgroup Logic Housing Operations Responds to subgroup raise or lower, MI raise or lower, and Reactor Power cutback. a. Subgroup raise or lower (SGR or SGL) (AS, MS, MI). (1) Common logic calls for SGR (a) Individual CEA enable card ensures no UEL or CWP. Sends CEA enable and WCE to all timer cards.	3. Review the acronyms: SGR, SGL, TMR EN, A,B,C,(x), UEL, LEL, MR/ML, CT, CWP, MI, MP, TMR CL, ICE, WCE. Display Transparency # T021 or Powerpoint slide series 'Subgroup Logic' and use it to review SGR and SGL functions, system time, manual individual raise and lower, and reactor cutback signals.
(b) Timer cards enabled; sequence upon TMR EN from slave subgroup sequencers in common logic. Timing sequence sent to coil driver actuating Logic cards.	(b) Timer sequence for WCE is set by 12 strip switches on the card, also 12 switches for ICE on card.ad of WCE.
(c) Coil Driver Cards selectively gate PHA, PLA trains from phase synch cards to fire SCR's.	(c) SGL operation is similar but uses ICE instead of WCE.
b. Manual Individual Raise or Lower. (1) MI enable signal (MI - (x)) from hold bus logic assembly. (a) Helps prevent inadvertent raise or lower of undesired CEA in MI mode. (b) Group Select Switch must be in the correct group for the individual CEA. (c) Two subgroup Manual Individual Logic cards in the Hold bus logic assy. decode this info and send the MI (X) signal to the appropriate subgroup's Individual CEA Enable and Pulse Count Logic Card. (2) MI (X), Manual Raise, and BCD code for CEA (one and tens select switch) needed for MI raise. (3) If phase sync pulse and CEA select card recognizes a BCD select code it sends an individual CEA selection signal to the Individual CEA Enable	

and Pulse count logic card; and to the appropriate Timer card. (4) If MI (X), MR/C, no UEL, and no timer busy - then Individual CEA Enable Card sends WCE to timer card. (5) If WCE, MR, MI (X), and CEA selection signal present - then timer card generates timing pulses for CEA withdrawal. (6) CEA MI motion rate set by strip switch (30"/min).	Show strip switches on timer card. Explain how the CT strip switch determines how long one cycle of motion will last and how this determines CEA speed
c. Reactor Power Cutback Signal When the CEA Logic Relay Interface receives a subgroup(s) drop and a subgroup arm for a particular subgroup; A Reactor power cutback command will be issued to both coil driver cards in the subgroup.	c. The coil driver cards will then send negating pulses to the SCRs causing all subgroup CEAs to gravity insert. Have students look at table from tech manual and build timing table for withdrawal and insertion on board.

EO: 1.9 Given a block diagram of CEDMCS, describe the function and operation of the major circuits and components of the common logic assembly.

Content	Methods and Activities
C. Common Logic Assembly Description Commands subgroup motion when called for by RRS or operator when in the MG, MS or AS modes. Provides system timing, reset, and alarm functions.	Show powerpoint slide series 'Common Logic'
1. Common Logic Circuit Cards.	
a. Clock distribution and subgroup cycle time card (1 each).	
b. System Clock and CMA Counter card (1 each).	
c. Aux Clock and CMA Timer card (1 each).	
d. Card Removal LED Drive circuit card (1 each).	
e. Reset, CMA and TFA circuit card (1 each).	
f. Control Group Raise/Lower Logic card (3 each).	f. #1 for Reg Grp 1 - 4 #2 for Reg Grp 5 - 8 #3 for SDA & B PS1 & 2
g. Master Sequence ÷ N and Raise/Lower logic card (2 each).	g. #1 for Reg Grps & #2 for power shaping grps
h. Master Subgroup Sequencer logic card (2 each).	h. #1 for Reg Grps & #2 for power shaping grps
i. Slave Subgroup Sequencer ÷ N logic card (6 each).	
j. Slave Subgroup Sequencer card (12 each).	j. 1 for each group of CEAs by design - 8 reg grps, 2 shutdown & 2 power shaping
2. System Timing and Reset Distribution	
a. Provided by Four cards.	
(1) System clock and CMA counter card.	
(2) Aux Clock and CMA Timer card.	
(3) Clock Distribution and subgroup cycle time card.	

Content	Methods and Activities
(4) Reset, CMA and TFA card.	
b. System Timing	
(1) System clock - CMA Counter Card has clock A and clock B.	
(2) Clock B is standby.	
(3) Clock output from clock failure select circuit (Sys CL(A) and Sys CL (B)) input to a ☐ 100 circuit to produce second clock (SCL).	
(4) SCL inputs a ☐ 6 circuit to produce a minute clock.	
c. Timer Failure Annunciator - (TFA)	
Alarm and system status light upon CEA timer board failure.	
d. Continuous Motion Annunciator (CMA)	d. Together the CMA timer and CMA counter circuit determine if a CMA condition exists.
Alarm is generated by CMA counter board when motion pulses are sensed for longer than a preset period.	
e. Reset Distribution	
(1) Manual and Automatic circuits reset proper logic levels to reset the common logic master and slave sequences clock circuits after a clock failure.	
(2) The Sequential Reset panel works with the Reset, CMA and TFA card to reset the CEDMCS timing.	
3. Common Logic Motion Rules.	3. N001-13.02-598 sh. 8
One Step Deviation between subgroups within a control group.	Display powerpoint slide series 'Common Logic' Common Logic Simplified
a. Signals needed by subgroup logic from common logic.	
(1) TMR CL (X).	(1) Output from clock distribution card
(2) TMR EN (X) or TEN (X).	(2) & (3) Output from slave sequencer card to specific subgroup

Content	Methods and Activities
(3) SGR (X) and SGL (X).	Explain that on common logic prints these are called CGR(x) and CGL(x), but that they are the same signals.
b. CEDMCS allows only one subgroup to move at a time.	260 milliseconds between each subgroup within a group
(1) Common logic sends TIM EN pulses count from 1 to 6.	
(2) Each subgroup wired to receive only one.	
(3) Each subgroup cycles in sequence.	
4. Common Logic Assy - Raise/Lower Logic a. Raise/Lower logic cards. (1) Master Sequencer ÷ N and raise lower logic cards. (2) Master Subgroup Sequencer logic cards. (3) Control group raise/lower logic cards. (4) Slave Sequencer ÷ N logic cards. (5) Slave Subgroup Sequencer logic cards.	a. Display Powerpoint slide series ‘Common Logic’and review the Raise/Lower logic cards.
b. Regulating Group Sequential Overlap (1) Provided to maintain a linear increase in Reactor power while maintaining a good flux balance in the core.	b. If necessary review with class why we have sequential overlap in the regulating groups.
(2) Sequence of events (a) 90" overlap between groups. (b) When group #1 at 90" group #2 begins traveling with it. (c) Group #1 stops at UGS, group #2 continues. (d) When group #2 at 90" group #3 begins traveling with it. (e) Process continues through group #5. (f) Process reversed for insertion.	Use powerpoint slide series ‘Common Logic’ for explanation of reg group overlap and rod worth.
c. Raise/Lower Logic Card Descriptions.	c. Display Powerpoint slide series ‘Common Logic’ for explanation
(1) Raise/Lower Logic card.	(1) Input requirements are:

Content	Methods and Activities
When input conditions are met, issues a CGR (X) or GGL (X) is issued to: (a) Master Sequencer ÷ N logic card. (b) Slave Subgroup Sequencer cards.	**For shutdown group:** MG mode, GRP/(W)/L, MR/L or ML/L and no UGS or LGS. **For regulating Group:** MG Mode - GRP(w)/L, MR/L, or ML/L
(c) Subgroup Logic Assemblies.	MS Mode - MS/L, MR/L or ML/L, at least one SP(w)/L AS Mode - AS/L, AR/L, at least one SP(w)/L And AWP/L, UGS, LGS, AMI must be satisfied **For PS groups:** GRP(w)/L, MR/L or ML/L, PS EN and no UGS or LGS.
(2) Master Sequencer ÷ N and Raise/Lower Logic Cards.	
(a) Controls 'R' and 'P' group CEA speed in MG, MS, and AS modes at either 30"/min - fast or 3"/min slow.	(a) Divides clock (R) from Master Subgroup Sequencer Card to produce Q(R) or (P) CEA speed clock. Outputs to Slave Subgroup Sequencer Cards.
(b) Sends ACGR to master sequencers when receiving more than one CGR signal.	(b) Receiving ACGR or ACGL enables Master Sequencer card.
(3) Master Subgroup Sequencer Logic Card (a) Synchronizes the slave subgroup sequencer cards for sequential overlap.	(3) Display powerpoint slide series ‘Common Logic’.
(b) Counter cycles through BCD count of 0-5 for raise and 5-0 for lower commands. (c) Receives Time Slot Busy (TSB) pulses and holds count until the time slot is not busy.	(b) Sequencer enable count (SEN) synchronizes the slave sequencer and enables their TEN outputs.
(4) Slave Subgroup Sequencer Logic Cards	

Content	Methods and Activities
Sequential Operation (a) Issues TEN pulses to enable the subgroups. (b) Two cards are enabled during overlap. (c) They will count together due to TEN pulses. (d) Alternating subgroup sequencers utilize the first three time slots for odd numbered cards and the last three for even numbered cards.	(b) Both will issue TEN counts from 1 to 6.
Example (for Reg Groups 3 and 4): Reg group #3 card Times X1, X2 and X3. Reg Group #4 card Times X5 and X6.	Illustrate example and have students attempt to follow using tech manual block diagram.
Sequence: 1. CGR(3) and (4) enable both subgroup sequencers. 2. Both count TEN pulses from 1 to 6. 3. Reg Group 3 has subgroups tied to first, second and third time slots (ignores 4,5,6). 4. Reg Group 4 has subgroups tied to fifth and sixth time slots (ignores 1-4). 5. On One count Reg Group 3 begins to withdraw. 6. On five count Reg Group 4 begins to withdraw 7. Repeats 8. Reverse for insertion (counts 6 to 1).	T/M pages 5-45 thru 5-47. Powerpoint slide series 'Common Logic'.
With no overlap, only one sequencer card is enabled and no SEN pulses are produced.	
d. Manual Group Operation	d. Display powerpoint slide series 'common Logic'
(1) Operator selects group motion at B04 and motion command (GRP and MR or ML) - sent to Control Group Raise/Lower Logic card	(1) GRP(1)/L thru GRP(8)/L is the signal sent to CEDMCS
(2) Control Group Raise/Lower Logic card issues CGR or CGL to the respective Slave Sequencer	
(3) Slave Sequencer acts like Master Sequencer did for sequential ops.	(3) It has timing input, CGR, GRP and outputs TEN 1 thru 6.

Content	Methods and Activities
(4) Slave Sequence ÷ N logic cards.	(4) Sets CEA speed for group motion when synchronization of the slave subgroup sequencers not required.
(a) sets timing for slave sequencer when in manual operation	(a) always for shutdown groups (only moved in manual op)
(b) 30"/min - fast, only speed.	Start with Common logic, connect to subgroup logic, go to power switch then to CEDM coils for chosen subgroup or CEA.
	Ensure students not only recognize component functions but locations in cabinets.
VI. CEDMCS Maintenance	
A. Surveillance Testing	
1. 36MT - 9SF01 CEA Reed Switch Functional Test	Functional Check of the NEW RSPT.
NOTE: RSPT zero position can change if RSPT transmitters are stepped on. DO NOT STEP ON RSPT TRANSMITTERS.	RSPT Removal RSPT Installation Adjustment of the RSPT Post Installation Check
a. Refueling internal test.	
b. All RSPT and CEA cables are disconnected at Reactor Vessel Head.	
c. The Reed Switch Test box is connected to each type 1 RSPT cable and 0", 75", 150" indications are verified.	
d. Each type 1 RSPT is then connected to its cable.	
e. Repeat for all type 2 RSPT's with the addition of verifying the DRC, LEL, UEL contacts.	
f. For the last RSPT tested off each power supply, fully loaded indications are noted. If not satisfactory, corrective maintenance on the affected power supply is performed.	
2. 36ST - 9SB10 Control Element Assembly Isolation Amplifier Functional Test.	The intent of this test is to verify the isolation characteristics of each Control Element Assembly Position Isolation

Content	Methods and Activities
a. Refueling interval test. b. For CEAC #1, PPS channel B is bypassed. For CEAC #2, PPS channel C is bypassed. c. The DNBR/LPD calculator test cart is hooked up to CEAC #1 and all software is verified. d. AC is applied to the input side of each I/A and output values are verified to be satisfactory. e. Repeated with AC on output and input values verified to be satisfactory. f. CEAC #1 is restored to normal. g. Repeat tests for CEAC #2.	Amplifier (CPIA) as required by Technical Specifications 4.3.1.4-a and 4.3.1.4-b.
3. 77ST-9RX01 Control Element Assembly Drop Time.(for units without CPC mod) –or- 73ST-9SB22 (for units with common Q CPCs installed.) a. Refueling interval test. b. Performed with OPS and Engineering support. Gives option to drop all rods at once and use special software in the CPCs and CEACs to verify drop times, or do one rod at a time. c. Shutdown Group A rods are pulled to UEL. d. A Astromed is hooked up to one CEDM power switch and corresponding RSPT. e. Astromed is started and power switch breaker is opened. f. Several seconds later, the Astromed is stopped and drop time verified to be less than 3.5 seconds. g. Repeat for all Group A CEAs. h. Repeat for Group B and all Regulating Groups.	This procedure verifies that CEA Drop Time is within Tech. Spec. Limits. Drop Time verification is required every 18 months or following work, such as Reactor Head Removal, that could affect CEA drop times.
B. Maintenance Testing 1. 36MT - 9SB01 Control Element Assembly Reed Switch Replacement a. Performed as required, by work order. b. RSPT is functionally tested using a test magnet to verify all reed switches, resistances, limit switches, and that no grounds are present. c. The old RSPT is removed. d. The new RSPT is installed and zero level adjusted. e. The RSPT is secured, restored to operation and verified.	
2. PM Task for CEDMCS Power Supply Calibration and LED Lamp Test. a. Lamp test is performed for all applicable components. This test lights all lamps on each unit as tested.	a. Lamp tests: •Power Switch Assemblies •Subgroup Logic Housings •Hold Bus Control and Indicator Panel

Content	Methods and Activities
	•CEA Relay Interface Housing •Supervisory Panel •Sequential Reset Panel •Common Logic Relay Interface •Common Logic Housing •RSPT Relay Interface Housing
b. For all cabinet power supplies:	b. Power supplies
(1) Measure output voltage (2) Adjust if required.	Relay P/S 1 & 2 Logic P/S 1 & 2 Aux P/S 1 & 2 Lamp P/S 1 & 2
(3) Measure AC ripple. (4) Measure Low Voltage detector voltage. (5) Adjust if required. (Steps 4 and 5 do not apply to Lamp Power Supplies).	for each cabinet as applicable.
3. CEDMCS Logic Housing Coil Voltage Calibration.	Also SWMS Routine Task numbers 066093, 066094, AND 066095 which are the old 36MT-9SF12 changed to SWMS tasks and set coil voltages off line during an outage.
a. Several specific potential equipment and personnel hazards exist in the performance of this procedure. Consult general and specific precautions. b. CEDMCS 3Φ input voltage is verified or adjusted to 138 VAC.	b. Static protection High voltages in cabinets Isolate test equipment Improper test connection damage.
	Can apply continuous HV to coil <u>no more than 1 minute</u>. Possible damage to coil due to heat and insulation breakdown.
c. All subgroups are sequentially tested as follows: (1) A test alignment within the cabinet is established. (2) Test equipment is installed. (3) CEDM's are run, one at a time.	

Content	Methods and Activities
(4) All coils are adjusted for □145VDC, high, and 40VDC, low.	(2) DMM, Oscilloscope, Astromed
(5) Voltages are then optimized for all 3 phases to be even in amplitude.	(5) Illustrate on board what the technicians should be observing on the o'scope.
(6) Test equipment is secured.	
(7) Cabinet is restored to normal alignment.	Inform the students they will be performing this calibration in rework as one of their LPEs.
4. 36MT-9SF13 CEDMCS CEA Coil Neutral to Ground Check	
a. An oscilloscope is connected between CEDMCS Neutral and Cabinet Ground at the output of the MG sets.	
b. Shutdown Group A is selected and CEAs are raised to 40" and reinserted.	
c. The oscilloscope is monitored for a wave form indicating a ground, and the ground fault alarm is monitored.	
d. If no ground is indicated Group A test is complete.	
e. If a ground is indicated, all Group A CEA's are individually run and ground(s) isolated and work order(s) initiated.	
f. This test is repeated for all CEA Groups.	
5. PM for CEDMCS Aux Cabinet Power Supply Calibration	(DIDA cabinets)
a. Both auctioneered power supplies are checked and calibrated in both C5 and C6 .	
b. The alarm functions are checked to the control room.	
6. 36MT-9SF15 CEDMCS Coil Traces at Power Operation	
a. CEAs are moved no more than 3 steps but are on hold bus and don't really move	
b. Astromed traces are taken and compared to appendix	b. Appendix A for withdrawal and B for insertion.
c. Care must be taken on comparison of traces with CEAs on HOLD bus. Upper gripper will appear different.	c. Explain in detail the key points of the coil trace. Point out the initial peak, timing, glitch when mechanical work done and difference in high, low and zero levels.
7. CEDMCS Logic Housing Coil Voltage Calibration at Power Operation	Rarely done, high risk test. We would rather do this shutdown
a. Procedure is basically the same as SF12.	
b. Precautions for one subgroup of CEAs at a time due to power operation.	
c. CEAs are on HOLD bus when performed.	

Content	Methods and Activities
d. Care must be taken in which cards are removed. Removal of wrong cards will cause dropped CEAs.	
e. Phase sync cards will be removed for subgroup and slot swapped	e. Ask if students know why? The reason is the subgroup shall be on the HOLD bus. The upper gripper coil will be constantly energized. To adjust the phase sync card it has to be placed in the lower coil position in that logic assembly to identify the output with M&TE.
f. Procedure is performed following corrective maintenance at power only.	f. Procedure is not designed to be performed in entirety.
C. Drawings and Prints 1. Consists of: a. Logic Drawings. b. Schematics. c. Hardware Diagrams. d. Wire Lists. 2. Drawing Numbers a. Bechtel Files. (1) N001-4.01-XXXX - Logic. (2) N001-13.02-XXXX - Most system prints.	C. Powerpoint slide series 'Tech manuals, drawings and wire ists'.
b. Electro Mechanics Numbers (1) 0000-38131 Typical (2) 0000 becomes 6324 or 6325 for PVNGS. (3) Find Electro-Mechanics in Tech. Manual and find Bechtel # using NSSS SDR cross reference. (4) Wire Lists (a) On Microfiche	Table 7-6 in the tech manual gives a cross from Electro-Mechanics vendor numbers to N001 (Bechtel) numbers Note: Table 7-6 on page 7-44 in the tech manual has a good reference of schematics crossed to their vendor drawing numbers. Table 7-7 starting on page 7-46 in the tech manual has a good list of wire lists crossed to their vendor numbers Once you know the vendor number, you can do a wildcard search in SWMS on the DMIMAIN page to find the palo verde document. This prevents having to use the SDR

Content	Methods and Activities
D. Helpful Hints	
1. Cautions	
a. For powered test equipment ALWAYS use an isolation amplifier.	
b. Have test equipment physically isolated from Astromed. Astromed can cause improper readings on voltmeter that is lying on top.	Except for the Astromed. SF15 allows use of the Astromed without an isolation transformer since it has built in isolation.
c. Have subgroup on hold bus when performing maintenance on subgroup logic cards to prevent dropping CEA's.	Do not use a Fluke 702. It gives false readings. This is noted in the procedures for the system
d. Boards may be removed or installed under power.	d. For example: CEA timer boards, Master/Slave sequencers. Show CE setpoint document.
e. Some boards must have strip switches set prior to installation (consult Tech Manual and check old board settings).	Show CEDMCS Trivia PPT slides and discuss events and OEs, CRDRS, etc.
f. Many boards are static sensitive.	
g. If system timing lost, it may have to be reset.	
h. Beware of HV present within CEDMCS cabinets and power switches.	
i. Use a lifting tool when moving power switches.	
2. Maintenance Experience	
a. Power switch failures were common but more recently only a few zero-crossover card failures have occurred	
b. Coil grounding problems were common early in plant life but have not been a problem of late.	
c. Edge connectors are a perennial problem.	
d. Subgroup failures more common than common logic problems. The vast majority of problems are with an individual CEA or subgroup.	
e. Logic can lockup if CEDMCS room temp is too high. Timer cards can spuriously lock up and need to be pulled, grounded out or have edge connectors cleaned. Pro-gold helps a lot.	
VII. Industry Events and PCP's	
A. Industry Events	
1. LER's	
a. 88-026-PVNGS Unit 1 was at 85% power	

Content	Methods and Activities
performing 41ST-1SF01, "CEA Operability Checks", with both CEACs declared inoperable when CEA #64 slipped 10 inches during testing. This condition was outside T.S. limitations which require < 6.6 inch misalignment when both CEACs are inoperable. The CEA was then successfully returned to satisfactory alignment.	
b. 88-020 PVNGS Unit 1 was at 85% power performing 41ST-1SF01, with both CEAC's declared inoperable when CEA #64 slipped 89 inches, again placing the plant outside T.S. limitations. It was then noted that CEA #57 had slipped 27 inches. Both CEA's were returned to satisfactory alignment.	b. CEA's #63 and #64 had previously slipped in May 1985 and CEA #64 had also slipped in October 1988. With CEAC's on line pretrips and one channel PPS DNBR and LPD trips were generated.
c. The cause of these events was determined to be an intermittent ground on the lower Lift Coil of CEA #64. Arcing of a bare wire to ground produced noise in the power supply output causing the control output voltage to drop to a value allowing slippage, potentially for all CEA's.	c. SER 19-89 also details the CEA slippage problems discussed under LERs 88-026 and 88-020.
2. SER's	
a. 19 - 89 PVNGS Unit 1 review of the LERs previously discussed.	
B. PCPs	
1. 13FJ- SF-027 - Replacement of undervoltage detectors	Installed in all units.
a. Output relays associated with the undervoltage detectors were sized improperly to carry the current required to operate the turbine trip relays. This was causing contacts to be welded together and burn open.	
b. Some of the output relays were chattering due to noise on the 240Vac bus.	
c. The undervoltage relays have a fixed setpoint of 216Vac phase-to-phase. This setpoint had the tendency to drift.	Installed in unit 1 & 2.
2. 13FJ-SF-029	
a. This change was to correct problem of lower lift coil moving in housing and chafing insulation causing ground.	
b. Coil wires for lower gripper were reversed.	
c. Lower lift timing was reduced at the high voltage level.	c. This caused the change in the coil trace for the lower lift coils. Some coil traces have the mechanical glitch right at the spike. This is considered acceptable.

Content	Methods and Activities
OE16876 / OE15405 (same event, 2 different OE numbers) What happened: At San Onofre they dropped a CEA even though they thought they had it on the hold bus. Why: connectors on the back of the power switch were not made up Can it happen here: Yes What can we do to prevent it: Monitor hold bus voltages and currents per the procedure before opening breakers on the power switch under maintenance to verify the rod or group is actually on the hold bus CRDR 2359176 Testing of CEDMCS can cause slight changes in reactivity. Only licensed operators are allowed to cause changes in reactivity.	On December 22, 2002, with San Onofre Unit 3 at 100 percent power, a Control Element Assembly (CEA) Power Switch assembly was downpowered and CEA 25 dropped into the core. The dropped CEA required a significant power reduction. The CEA was retrieved after a Power Switch Assembly was replaced, and power was restored to full power. A CEDMCS Timer Failure alarm was received and then cleared as a result of a CEA transferring from the upper gripper to the lower gripper. Inspection of the Automatic Control Element Drive Motor Timer Module (ACTM) circuit cards status LEDs for the CEA showed abnormal voltage and the Lower Gripper engaged. Twenty-four minutes later the alarm occurred again. The CEA subgroup was placed on the Hold Bus and troubleshooting with Maintenance & Engineering began shortly thereafter. As a part of that troubleshooting, the Power Switch module was downpowered, and the CEA unexpectedly dropped into the core. Reactor power was reduced to approximately 40 percent to meet core operating limits with a dropped CEA. The CEA was retrieved after a Power Switch Assembly was replaced for that CEA Subgroup. Causes: The CEDM power is provided via interconnecting cables, connectors and terminal blocks from a power switch assembly. The power switch assembly is made up of many different components including powerconnectors on the back plane of the power switch assembly. The two mating connectors of the supply switch were inspected and found that the plug and socket had heat damage, half of the socket's mating surface was rolled back, and the plug was not captive. Because the plug was not captive it was allowed to slide back during

Content	Methods and Activities
	the engagement process and the rolled part of the socket was caused by misalignment during engagement. The sliding back into the connector housing was not visible because the plug portion of the connector is mounted on the back plane of the power switch assembly. The expectation for the CEA was that the hold bus was maintaining the UG engagement when in fact the UG was not engaged. There is no positive indication that a gripper is engaged. During the hold bus transfer process, the CEDM transferred from the UG to the LG between the time the manual transfer switch of the ACTM was operated and the time the upper gripper was powered from the hold bus. The ACTM transferred gripper engagement because of inadequate UG holding current because of a damaged connector. Since the hold bus voltage is not sufficient to engage the gripper, the CEA dropped to the bottom of the reactor core when it's respective breaker was opened on the power switch assembly. Unit 3 at SONGS has twenty-six Power Switch Assemblies of which each assembly has six multi-pin connectors that have to make up blindly and simultaneously during installation. Corrective Actions: Power Switch Assembly and new replacement connector parts were installed as an immediate corrective action. A procedure was changed to provide additional information such as identification of other indications that can be used for core power, guidance to EOL reduction, time for monitoring DNB/LPD, directions for requesting assistance and tilt value expectations. Other procedure changes were made to maintain continuous monitoring of the ACTM's Upper Gripper LEDs to insure they remain illuminated until the Subgroup Maintenance switch is operated. Another

Content	Methods and Activities
	procedure was changed to force the lower grippers to be engaged when coming off the hold bus. This will reduce the possibility of dropping a CEA when coming off the hold bus by forcing/verifying the lower gripper is engaged prior to going to off for the hold bus, thus protecting against loss of upper gripper power from the power switch drawer. Safety Significance: None. This event did require operators to reduce power and perform a CEA recovery near the end of core life when ASI control is more difficult. This event is not significant because no safety limits were exceeded. This event is NOTEWORTHY because the dropped CEA required that reactor power be reduced during troubleshooting and repair activities and required the operators to perform a CEA recovery. Information Contact**: C. Schmidt**, Maintenance Engineer (949) 368-5119, schmidcr@songs.sce.com (#021201125-2) Mike Marienthal, Nuclear Network Coordinator (949) 368-6041, marienmj@songs.sce.com Important points to make: -We have the same type of blind connectors on the back of our power switches -The hold bus did not save them -They didn't trip, but they did have to significantly reduce power Our check of hold bus amps and volts should prevent this at Palo Verde Palo Verde uses a Phase Sync Test Card to perform coil voltage adjustments and for performing certain troubleshooting steps. This card allows energization of selected CEDM coils. This card is used near the end of each refueling outage to adjust coil voltages. The voltage adjustment are normally

Content	Methods and Activities
	performed with all CEA's fully inserted. The test card is normally used to energize one coil at a time and consequently does not normally result in CEA motion. However, the test card switches are in close proximity and two coils could inadvertently be turned on. Momentarily turning on two coils does not cause problems with the CEDMCS system, but this could cause the subgroup CEA's to lift approximately 7/16 inch. Cover any recent maintenance, lessons learned, OE or industry events.

EO: 1.10 Using the CEDMCS technical manual, system drawings and the CEDMCS simulator, locate specific equipment and identify their function within CEDMCS.

Content	Methods and Activities
I. CEDMCS Documentation	Show students copies of all technical manuals.
A. Technical Manuals	
1. VTD E146-0008 CEDMCS manual	
2. VTM-E146-00001 CPIA manual	
3. VTD C490-0032 CEDMCS Aux Cabinet manual	
4. C490-0008 Mag Jack CEDM manual	
B. Prints	
1. N001-4.01 & N001-13.02 2. 0000 a. substitute 6324 or 6325 b. prints with substituted numbers are PVNGS specific	1. Bechtel numbering 2. Original Electro-Mechanic prints NID28-L-001 will involve signal tracing An example troubleshooting problem will be used during the lab where the students will follow the signal from point to point inside the cabinet.
C. Wire Lists 1. Contained on micro-fiche in card files 2. Only wire lists show interconnections 3. Must know signal abbreviation	Give students brief description of how to signal trace in CEDMCS. Explain there is no interconnection diagrams. Only block & assembly diagrams and schematics exist.

EO: 1.11 Perform a pre-job brief for the performance tasks

Content	Methods and Activities
This objective was included to satisfy the requirements of 15DP-0TR69 section 10.2. **Expectation**: A prejob briefing is a dialogue between workers and leaders held prior to performing a job to discuss the tasks involved, hazards, and related safety precautions.	Pre-job briefs increase our chance of success Who, what, when, where, why, how *Ask students why we do a pre-job brief.* Why: Provides an opportunity to orient the performer or team to the critical steps of the task and possible error/event scenarios. A well executed prejob brief identifies error-likely situations, barriers to those situations, and the roles and responsibilities of each task performer. *Ask if pre-job briefs are appropriate for simple jobs? For jobs you will work alone?* *Are pre-job briefs only needed for field work?*
Why Use the Tool: • Ensures understanding of task scope • Ensures understanding of roles and responsibilities • Anticipates problems and identifies expected responses • Discusses Palo Verde and/or industry lessons learned in performing the task • Minimizes the potential for making mistakes	*Ask the students: What if all participants can not be present?* *Ask the students: Can a pre-job brief be done a month before a job?* *Answer: Yes, but another one must be done just prior to the actual job.*
When to Use the Tool: • Before the start of assigned work tasks • Prior to work activities involving plant • Once per shift, if the activity exceeds • After extended delays in an activity	*Ask the students how to identify critical steps and irreversible actions.*

Content	Methods and Activities
How to Use the Tool: • Using a graded approach, address the details pertinent and important to the task at hand.	Ask the students when a formal hazard analysis is required?
Focus-on-Five • What are the critical steps of the task I'm going to perform? What document describes it? Do I understand it? • What is the worst thing that can happen and how can I prevent it? • What else could go wrong? • What are the safety and / or radiation protection considerations? • Is my training and are my qualifications up to date?	Demonstrate for the students how to check quals on the computer using http://pvonline or http://kiosk
Detailed Briefing Checklist • Task purpose, scope, and nature of work • Review of procedures, work package documents, drawings, turnover information, prerequisites, etc. • Task assignments, roles and responsibilities, qualifications, personal limitations, handoffs, and the controlling authority • Safety hazards and mitigating methods • Use of HU tools for each critical step • Special requirements or unusual conditions • Operating experience specific to the task Stop-work criteria, reviewing contingencies, changes in task conditions or its scope, and person(s) responsible for making critical decisions • Leader Oversight • Worker questions and concerns	
Sensitive Issues Manual The Sensitive Issues Manual briefs certain sensitive evolutions and activities performed at Palo Verde. Consult	Demonstrate for the students how to find the sensitive issues manual using

Content	Methods and Activities
an Operations Department Leader or shift manager if in doubt.	http://pvonline/prevent_events.htm
At-Risk Practices (Short List): • Discussing human performance tools in generalities • Conducting the meeting as a monologue, without active participation by the assigned worker(s) • Workers failing to express their concerns or ask questions • Using a "cookbook" approach to the briefing covering every item on the prejob briefing checklist regardless its applicability • Not assigning individual-specific responsibilities for contingencies and abort decisions • Conducting the meeting in a noisy, distracting environment • Not considering equipment work history or the worker's personal experience as relevant sources of operating experience • Covering operating experience irrelevant to the task	

EO: 1.12 Using the CEDMCS simulator and all necessary equipment, calibrate the CEDMCS logic housing coil voltage.

Content	Methods and Activities
II. Coil Voltage Adjustment Routine Task shutdown, and 36MT-9SF16, Coil Voltage Adjustment at power	II. Coil Voltage Adjustment LPE: setup students to perform the phase sync calibration.
A. CEDM Power Supply Calibration SWMS RT must have been performed.	
1. Several specific potential equipment and personnel hazards exist in the performance of this procedure. Consult general and specific precautions.	Static protection High voltages in cabinets Isolate test equipment Improper test connection damage. **Can apply continuous HV to coil <u>no more than 1 minute.</u>**
B. CEDMCS 3 input voltage is verified or adjusted to about 140 VAC.	
C. All subgroups are sequentially tested as follows:	
1. A test alignment within the cabinet is established.	
2. Test equipment is installed.	2. DMM, Oscilloscope, Astromed
3. CEDM's are run, one at a time.	
4. For all coils ULH and ULL are adjusted.	
5. Voltages are verified.	
6. Test equipment is secured.	
7. Cabinet is restored to normal alignment.	

EO: 1.13 Using the CEDMCS simulator and all necessary equipment, obtain CEA coil traces.

Content	Methods and Activities
III. 36MT-9SF15 Obtaining CEDMCS Coil Traces at Power Operation	III. Lab Practical Evaluation: Ensure students fully understand how to setup the Astromed Recorder. Also its importance on the 3-monthly procedure vs. troubleshooting
A. Coil traces are taken in both coil voltage calibration procedures and the coil neutral to ground checks also.	
B. Coil traces are utilized for troubleshooting	
C. CEAs are moved no more than 3 steps	
D. Astromed Recorder traces are taken and compared to appendix.	Students should obtain coil traces on the HOLD bus and the normal power switch.
E. Care must be taken on comparison of traces with CEAs on HOLD bus. Upper gripper will appear different.	The LPE evaluation will be their correct identification of the coil traces and comparison to the SF15 appendices.

EO: 1.14 Using the CEDMCS simulator and all necessary equipment, including appropriate prevent event tools, troubleshoot and rework CEDMCS.

Content	Methods and Activities
IV. Troubleshooting A. Power Switch Assembly failures were common right after startup. B. Coil grounding problems were common but we haven't had one recently. C. Subgroup failures are the most common logic failure (☐90%). D. Edge connectors are a perennial problem. E. Logic can lock-up if CEDMCS room temperature is too high. **F.** Coil Driver Cards, CEA timer cards, Phase Synch Pulse and CEA Select cards have had high failure rates. **G.** Operator Module failures have also been seen. **H.** A troubleshooting guide is included in section VII of the CEDMCS Tech. Manual.	
Give LPExercises	LPExercise numbers: NID2801001 Coil Voltage Calibration NID2801002 Coil Traces NID2801003 Troubleshoot CEA Position NID2801004 Troubleshoot CEDMCS system
I. Cognitive Evaluation	
II. Summary A. Objectives review B. Topic review	A. Review the lesson enabling objectives B. Restate or review the main principles or ideas covered in the lesson
	A. Ask questions which implement the objectives. Discuss students' answers as needed to ensure the

Content	Methods and Activities
III. Questions and Answers A. Oral questions	objectives are being met. III. Review any problem areas discovered during the oral questioning. Use this opportunity to solicit final questions from the students (last chance).
III. Problem Areas	IV. Read or have the students read applicable SER's, EER's, etc.; especially those which deal with PVNGS. Have students discuss the reports and decide what actions were incorrect, and what actions should have occurred.
IV. Lessons Learned	V. Review the motivational points which apply this lesson to the students' future and present needs. Use this opportunity to address an impending exam.
V. Concluding Statement	

SUMMARY OF MAIN PRINCIPLES

The following items are things to consider in your lesson summary. They are not mandatory. You should develop your own summary.,

Objectives Review

Review the Lesson Objectives

Topic Review

Restate the main principles or ideas covered in the lesson. Relate key points to the objectives. Use a question and answer session with the objectives.

Questions and Answers

Oral questioning

Ask questions that implement the objectives. Discuss students answers as needed to ensure the objectives are being met.

Problem Areas

Review any problem areas discovered during the oral questioning, quiz, or previous tests, if applicable. Use this opportunity to solicit final questions from the students (last chance).

Concluding Statement

If not done in the previous step, review the motivational points that apply this lesson to students needs. If applicable, end with a statement leading to the next lesson.

You may also use this opportunity to address an impending exam or practical exercise.

Should be used as a transitional function to tie the relationship of this lesson to the next lesson. Should provide a note of finality.