PALO VERDE
NUCLEAR GENERATING STATION

Licensed Operator Initial Training

Classroom Lesson

Licensed Operator Initial Training	**Date: 5/5/2010**
LP Number: NKASYC014903	**Rev Author: CARL D. HORN**
Title: Plant Protection System Lesson Plan	**Technical Review:** James Ledford Digitally signed by James Ledford DN: cn=James Ledford, c=US, o=Licensed Operator Initial Training, ou=9617, email=Z59833@apsc.com Date: 2010.05.10 18:15:36 -07'00'
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INITIATING DOCUMENTS

Licensed Operator Initial Training - Training Program Description

Reactor Operator Task List and Training Recommendations

Senior Reactor Operator Task List and Training Recommendations

REQUIRED TOPICS

TCS 90-015 SOER 83-8 Reactor Trip Breaker Failures, 10 October 1983, Training Recommendation 11b

TCS 94-1413, 94-1268 RCP motor winding failure due to Rx Trip while ESFAS relay testing wrong containment spray train. LER 94-0002

TCS 96-0418 SO Report 95-03, Inappropriate bypassing of PPS.

CONTENT REFERENCES

STM Volume 49, Plant Protection System (PPS - SA/SB)

36ST-9SA01 ESFAS TRAIN A SUBGROUP RELAY FUNCTIONAL TEST

36ST-9SA02 ESFAS TRAIN B SUBGROUP RELAY FUNCTIONAL TEST

41AL-1RK5A PANEL B05A ALARM RESPONSES

40AL-9RK5B PANEL B05B ALARM RESPONSES

LESSON PLAN REVISION DATA

May 05, 2010	Dan Horn	Rev 03 updated lesson to reflect setpoint changes. TCSAI 3471971 CDH

Tasks and Topics Covered

The following tasks are covered in Plant Protection System Lesson Plan :

Task or Topic Number*	Task Statement

Lesson: Plant Protection System Lesson Plan

1030040001	Perform ESFAS subgroup relay monthly functional test
1030030001	Bypass DAFAS
1240022801	Perform RAS check/reset
1240022401	Perform CIAS check/reset
1240022701	Perform CSAS check/reset
1240022601	Perform MSIS check/reset
1240022501	Perform AFAS check/reset
1240022201	Perform SIAS check/reset
1280010801	Perform surveillance test
1240021901	Direct reset and reenergization of SIAS load shed panels
1040010401	Operate reactor protection system reactor trip breakers
1260010101	Respond to an alarm
1290520302e1	Ensure maintenance of technical specification component condition record

Total task or topics: 13

TERMINAL OBJECTIVE:

1 Given a presentation covering the topics in this area, the operator will demonstrate mastery of the knowledge objectives associated with the Plant Protection System by scoring 80% or better on an exam(s) that sample the associated objectives.

1.1 Describe the composition, purpose, and general methodology of the Plant Protection System.

1.2 Describe the general design criteria of the Plant Protection System.

1.3 Describe the basic building blocks of the RPS.

1.4 Describe how the Reactor Protection System achieves its purpose and draw a functional diagram of RPS.

1.5 List the parameters and setpoints that will cause PPS actuation.

1.6 Describe the systems needed to support the Reactor Protection System.

1.7 Describe the color scheme associated with PPS instrument channels.

1.8 Describe the PPS instrumentation monitoring excore neutron flux including its function, bases, and setpoint (as described in the Technical Specifications).

1.9 Describe the PPS instrumentation associated with RCS Low Flow, including its function, bases, and setpoint (as described in the Technical Specifications).

1.10 Describe the PPS instrumentation associated with Pressurizer Pressure - Narrow Range including its function, bases, and setpoint (as described in the Technical Specifications).

1.11 Describe the PPS instrumentation associated with Pressurizer Pressure - Wide range including its function, bases, and setpoint (as described in the Technical Specifications).

1.12 Describe the PPS instrumentation associated with Steam Generator Pressure including its function, bases, and setpoint (as described in the Technical Specifications).

1.13 Describe the PPS instrumentation associated with Wide range Steam generator Level including its function, bases, and setpoint (as described in the Technical Specifications).

1.14 Describe the PPS instrumentation associated with Containment pressure including its function, bases, and setpoint (as described in the Technical Specifications).

1.15 Describe the PPS instrumentation associated with Narrow range Steam generator Level including its function, bases, and setpoint (as described in the Technical Specifications).

1.16 Describe the PPS instrumentation associated with Wide range Containment pressure including its function, bases, and setpoint (as described in the Technical Specifications).

1.17 Describe the PPS instrumentation associated with RWT Level including its function, bases, and setpoint (as described in the Technical Specifications).

1.18 Describe how the PPS compares an input signal to a setpoint and generates an output if that setpoint is exceeded.

1.19 Describe how Coincident Matrix Logic functions to cause a PPS trip.

1.20 Describe how matrix logic receives electrical power.

1.21 Describe the interface between matrix relays and initiation circuits in the RPS.

1.22 Describe how RTCBs are tripped and what indication of trip path status is available.

1.23 State the RTCB control power source.

1.24 Describe the RPS operating bypasses.

1.25 State the purpose of a trip channel bypass and describe its operation.

1.26 Describe the RPS Trip Channel bypass interlock.

1.27 Describe the RPS Power Trip Test Interlock.

1.28 Describe the CPC test interlock associated with the RPS.

1.29 Describe the Nuclear Instrument Testing interlock associated with the RPS.

1.30 Describe the Matrix Testing Interlock associated with the RPS.

1.31 Describe the RPS controls and indications available for the operator at B05.

1.32 Describe the RPS controls and indications available to the operator at the PPS status panels.

1.33 Describe the RPS controls and indications available to the operator at the Bistable Control Panel.

1.34 Describe the RPS controls and indications available to the operator at the Trip and Pretrip setpoint potentiometer Panel.

1.35 Describe the RPS controls and indications available to the operator at the Matrix Test Module.

1.36 Describe the RPS controls and indications available to the operator at the Initiation Reset Panels.

1.37 Describe the RPS indications available to the operator relating to the following auxiliary functions:

- Relay Card Rack
- Cabinet Cooler Assembly Controls
- Power Supply Panels

1.38 Describe the RPS related controls and indications located at the Remote Shutdown Panel.

1.39 Describe the RPS controls and indications available to the operator at the Reactor Trip First Hit Alarm Panel.

1.40 Describe how ESFAS initiation differs from RPS actuation and draw a functional diagram of ESFAS.

1.41 Describe what automatically initiates the Safety Initiation Actuation System (SIAS) and its function.

1.42 Describe what automatically initiates the Containment Isolation Actuation System (CIAS) and its function.

1.43 Describe what automatically initiates the Containment Spray Actuation System (CSAS) and its function.

1.44 Describe what will automatically initiate a Recirculation Actuation Signal (RAS) and its function.

1.45 Describe what will automatically initiate a Main Steam Isolation Signal (MSIS) and its function.

1.46 Describe what automatically initiates Auxiliary Feedwater Actuation Signal (AFAS) and its function.

1.47 Describe how the AFAS lockout functions to block AFAS.

1.48 Describe how ESFAS signals are manually initiated by the operator.

1.49 Describe the ESFAS Initiation Logic Circuits and their function.

1.50 Describe the purpose of the Auxiliary Relay Cabinets.

1.51 Describe the ESFAS Aux Relay Cabinet actuation and lockout relay arrangement for CIAS, CSAS, MSIS, RAS, and SIAS.

1.52 Describe how an ESFAS subsystem can be manually actuated and manually reset from the Aux Relay Cabinets.

1.53 Describe the actuation and lockout relay arrangement associated with AFAS/DAFAS.

1.54 Describe the ESFAS controls and indications available for the operator at B05.

1.55 Describe the indications available on the PPS status panels.

1.56 Describe the ESFAS controls available to the operator at the Bistable Control Panel.

1.57 Describe the controls and indications associated with the Auxiliary Relay Cabinets.

1.58 Describe the purpose of the Aux Relay Test Cabinet and general test methodology.

1.59 Describe the Supplementary Protection System including its function, instrumentation, bases, and setpoint (as described in the Technical Requirements Manual).

1.60 Describe the output functions of the Supplementary Protection System initiation relays.

1.61 Describe the Diverse Aux Feedwater Actuation System (DAFAS) including its function, methodology, and setpoint (as described in the Technical Requirements Manual).

1.62 State the LCOs associated with the Reactor Protection System Logics and Manual Initiation, including their bases.

1.63 State the LCOs associated with the Reactor Protection System, including their bases.

1.64 State the LCOs associated with the Engineered Safety Features Actuation System (ESFAS) including their bases.

1.65 State the LCO associated with the Engineered Safety Feature Actuation Logics and Manual Initiation, including its basis.

1.66 Describe the alarms associated with the Plant Protection System including their cause and designated operator actions.

Knowledge of the Plant Protection System is central to the job of the Reactor Operator as PPS initiates all of the systems required to ensure the plant operates within design limits under adverse circumstances. The ability to anticipate and ensure the proper function of the various subsystems controlled by PPS along with ensuring compliance with the associated Tech Specs is central to the safe operation of the power plant.

This lesson plan is designed to give the license candidate all the tools necessary to attain the required abilities.

The following topics are required to be discussed during this lesson:

TCS #90-015 SOER 83-8 Reactor Trip Breaker Failures, 10 October 1983, Training Recommendation 11b

Event Description

On two separate occasions, both reactor trip breakers (Westinghouse Model DB-50) failed to open following receipt of a trip signal from the reactor protection system. On both occasions, the reactor was tripped manually from the control room. The root cause of the failure could not be determined, however, inadequate preventative maintenance was a major contributor to the failures. The trip breakers were not included in the PM Program. Failure to perform an adequate post trip review contributed to the failure to recognize the initial failure.

Event Significance

Failure of the RTSG's to automatically open when required places total reliance on operator action to terminate a plant transient. Failure to initiate a reactor trip during a loss of feedwater transient results in a potentially severe primary system heatup and pressure increase. If a manual reactor trip is delayed and pressure increases beyond limits, permanent damage to components and systems may occur.

How do we prevent Occurrence

PVNGS utilizes Westinghouse reactor trip breakers type DS-416 which are subject to similar failures experienced with the DB-50 breakers. The RTSG at PVNGS are included in the Preventative Maintenance Program and are inspected in accordance with the Vendors recommendations. Additionally, the RTSG are tested monthly in accordance with Technical Specifications. PVNGS also performs detailed post trip reviews to ensure root cause of the trip and component failures are not overlooked.

<u>How do we Mitigate the Event</u>

SPTAs

- Verify CEAs inserted, Neg. SUR, Power Decreasing
- If not, Manually trip reactor using pushbuttons on B05
- If still not tripped, then De-energize L03 & L10 for approx. 5 seconds.
- Send an operator to locally trip RTSG
- Emergency Borate the RCS

SPS

- The SPS will trip the RTSG and CEDMCS MG Set output contactors when pressurizer pressure reaches 2409 psig.
- The MG Set Contactors will interrupt power being supplied through the RTSG to the CEDMCS power switch assemblies.

TCS#96-0418 SO Report 95-03, Inappropriate bypassing of PPS

<u>Event Description</u>

This report describes events at numerous power plants which demonstrate that operators can pose a challenge to the design defense in depth of plants, even during uncomplicated events. This report concludes that several plants have not consistently determined, communicated and implemented a policy defining when it is and is not appropriate to bypass, defeat, or turn off a safety system. Procedures and other written guidance sometimes did not provide clear, consistent guidance to address situations where safety systems should be throttled, bypasses, turned off or reconfigured, and when they should be reset or reinitiated. Operators were not consistently fully knowledgeable of emergency operating procedures, there bases, and appropriate ESF control practice in that some operators had difficulty in using procedures during routine, uncomplicated events. Poor watch standing practices in the areas of communication, shift turnover, control board walkdown, verification of automatic actions, and response to alarms contributed to in appropriate ESF defeats and delayed their recognition and recovery. An ESF was considered to be inappropriately defeated if:

- It was defeated contrary to applicable licensing requirements, operating procedures, or training
- It was not initiated when called for by applicable procedures or not promptly recovered.

Examples of inappropriately defeated systems due to maintenance, surveillance or operating activities also occurred.

Event Significance

Appropriate control of engineered safety features is an essential element of reactor safety, as evidenced by the Three Mile Island Unit 2 and Chernobyl Unit 4 accidents, in which operators defeated ESFs that could have prevented or mitigated the accidents.

How do we prevent Occurrence

- Conduct of Shift Operations
- Only allow the Bypassing of PPS trip as directed by approved procedure.
- Independent verification
- TSCRRs (Records and tracks TS actions)
- Operability Determination (helps provide method for historical archive of determination of affected equipment to plant conditions.)

How do we Mitigate the Event

SEAS alarms will inform the operator of any time an ESFAS actuation does not completely actuate and will also monitor the equipment for time it is placed in a state where it will not function when called upon.

TCS #94-1413, 94-1268 RCP motor winding failure due to Rx Trip while ESFAS relay testing wrong containment spray train. LER 94-0002 PVNGS Unit 2

Event Description

I & C testing of ESFAS relay caused CS Valve to open and a DNBR trip occurred, due to a loss of 1B RCP whose electrical power connection box exploded due to borated water running down the power cable, shorting out the connection.

Borated water came from RWT and gravity fed through Auxiliary Spray Header (7000 gallons).

RWT water flowed through de-energized open spray header isolation due to the valve relay being deenergized. ("B" train SI-671 received open signal.)

Causes:

- I&C was supposed to de-energize "A" train K111 relay, but de-energized "B" train. Personnel error.
- Inattention to detail by maintenance and OPS
- Lack of self-verification
- Poor communications, inadequate briefing.

Event Significance

- Reactor Trip
- RCP Damage
- Increase of spread of Contamination when RWT water sprayed in CNMT.
- Impacting both trains of ESFAS equipment
- Testing of one train with equipment inadvertently actuating on the other train.

How do we prevent Occurrence

Emphasizing STAR techniques and using Ops Standards and Principles on Communications.

Formal communication will be used when direction is being given provided to operate plant equipment, in reporting critical plant information, and during abnormal operations.

Elements of formal communications include:

- Use of ,short concise and clear repeat-backs and paraphrasing.
- Use of the phonetic alphabet when part of the message contains a single letter of the alphabet.
- Use of accepted standard terminology.
- Messages have sufficient content to ensure the correct information is exchanged.
- Because of different terminology, a higher level of awareness is needed when communication is with other departments.

How do we Mitigate the Event

An Inadvertent ESFAS is mitigated using Abnormal Operating Procedure.

TO: 1 Given a presentation covering the topics in this area, the operator will demonstrate mastery of the knowledge objectives associated with the Plant Protection System by scoring 80% or better on an exam(s) that sample the associated objectives.

EO: 1.1 Describe the composition, purpose, and general methodology of the Plant Protection System.

Introduction

The Plant Protection System (PPS) is designed to protect the plant from the consequences of off normal or accident conditions.

Main Idea

The Plant Protection System (PPS) consists of the Reactor Protection System (RPS), the Engineered Safeguards System (ESFAS), the Supplementary Protection System (SPS) and the Diverse Auxiliary Feedwater System (DAFAS).

The PPS is designed to ensure that certain vital plant functions such as tripping the reactor and initiating post accident safety systems occur when needed. PPS accomplishes this purpose by using four independent channels of safety grade instrument loops to monitor plant conditions and six independent logic matrices to process output of the instrumentation and initiate protective actions if warranted.

EO: 1.2 Describe the general design criteria of the Plant Protection System.

Introduction

Coming from 10CFR50 App "A":

Main Idea

PPS

- Initiate automatically the operation of appropriate systems including the reactivity control systems to assure that specific acceptable fuel design limits and the pressurizer pressure safety limit are not exceeded as a result of anticipated operational occurrences.
- Sense accident conditions and to initiate the operation of systems and components important to safety.
- High functional reliability and in service testing commensurate with the safety functions to be performed.
- Redundancy and independence designed into the protection system shall be sufficient to assure that:
- NO single failure results in loss of the protection function.
- NO single failure will cause an actuation of the protective function.
- Removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated.
- Permit periodic testing of it's functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred.

SPS/DAFAS

10CFR 50.62

Each pressurized water reactor must have equipment from sensor output to final actuation device that is diverse from the reactor trip system, to automatically initiate the auxiliary (or emergency) feedwater system and initiate a turbine trip under conditions indicative of an ATWS.

This equipment must be designed to perform its function in a reliable manner and be independent (from sensor output to the final actuation device) from the existing reactor trip system.

Each pressurized water reactor manufactured by Combustion Engineering must have a diverse scram system from the sensor output to interruption of power to the control rods. This scram system must be designed to perform its function in a reliable manner and be independent from the existing reactor trip system (from sensor output to interruption of power to the control rods).

EO: 1.3 Describe the basic building blocks of the RPS.

Introduction

Although RPS is a relatively complex system it can be effectively analyzed by considering each of the following separately.

Main Idea

- Instrumentation feeding the RPS
- Processing of instrument signals
- Logic Operations
- Outputs--which consists of tripping action, alarms and indication.
- Controls--consisting of bypasses, resets, and manual actuations.

EO: 1.4 Describe how the Reactor Protection System achieves its purpose and draw a functional diagram of RPS.

Introduction

The Reactor Protection System ensures the Reactor will trip if any of a number of off normal conditions occur.

Main Idea

There are a total of four independent sensing channels (A, B, C and D) monitoring each parameter that has the potential to cause a Reactor trip. Every possible combination of two such channels is represented by a single matrix logic array which will deenergize its associated four tripping relays if both of its input sensor channels sense the same parameter exceeding its trip setpoint. There are six matrices:

AB; AC; AD; BC; BD; CD.

When the matrix relays are deenergized, contacts will open in the trip circuit breaker control circuitry causing the Reactor trip circuit breakers to open and the CEDMs to deenergize, dropping control rods into the core.

Your drawing should include:

- Typical field inputs
- Logic matrices
- Matrix relays
- Matrix Power supplies
- Initiation relay contacts
- Trip Circuit breakers for RPS (including shunt and UV coils)
- Aux relay cabinets for ESFAS

The level of detail for the drawing should demonstrate your understanding of how PPS causes the reactor to trip.

EO: 1.5 List the parameters and setpoints that will cause PPS actuation.

Introduction

The following table is designed to provide the student with all the necessary information to study the PPS setpoints and initiating parameters. The student will be responsible for the actual setpoints which are set more conservatively than the Tech Spec required set points.

Main Idea

TRIP/ACTUATION	INSTRUMENT	SETPOINT	ACTUATION
Variable Overpower	**Safety Channel NIs**	**Fixed set point at 110% power. Variable set point at 9.7% above steady-state power. Rate of change at 10.6% per minute.**	**Reactor trip**
High Log power	**Log signal from middle detector of each Safety channel NI**	**>.01% power. (bypassed on power increase)**	**Reactor trip**
High Local Power Density (LPD)	**Originating in CPCs**	**>21 kw/ft.**	**Reactor trip**
Low DNBR	**Originating in CPCs**	**< 1.34**	**Reactor trip**
High Pressurizer pressure	**PT-101A-D, narrow range PZR pressure**	**>2383 psia**	**Reactor trip**
Low Pressurizer pressure	**PT-102 A-D, wide range PZR pressure**	**<1837 psia (variable)**	**Reactor trip** **SIAS** **CIAS**

Low Steam Generator Pressure	PT-1013 A-D (SG-1) PT-1023 A-D (SG-2)	<960 psia (variable) SG-1 and SG-2 difference >185 psi	Reactor trip MSIS AFAS lockout to SG with lowest pressure
Low Steam Generator Water level	LT-1113 A-D (SG-1) LT-1123 A-D (SG-2) (Wide ranges)	< 44.2% < 25.8% < 20.3%	Reactor trip AFAS initiation DAFAS Initiation input
High Steam Generator Water level	LT-1114 A-D (SG-1) LT-1124 A-D (SG-2) (Narrow ranges)	> 91%	Reactor trip MSIS
High Containment Pressure	PT-351A-D (Narrow Range)	> 3 psig	Reactor trip SIAS CIAS MSIS
High-High Containment Pressure	PT-352 A-D (Wide Range)	> 8.5 psig	CSAS
Low Reactor Coolant flow	PD-115 A-D(SG-1) PD-125 A-D(SG-2)	variable	Reactor trip
Low RWT level	LT-203 A-D	<7.4%	RAS

EO: 1.6 Describe the systems needed to support the Reactor Protection System.

Introduction

There are a number of systems requires to support operation of the RPS.

Main Idea

Core Protection Calculators

The four Core Protection Calculators provide DNBR Low and LPD High trip and pre-trip inputs to the RPS (as well as several auxiliary trips that use the DNBR and LPD bistables). The DNBR Low and LPD High trip and pretrip signals are input directly to the Bistable Relay Cards.

Class 1E Instrument AC Power

Each RPS channel has its own independent and redundant Class 1E, 120 VAC power sources.

Class 1E 125 VDC Power

Supplies 125V DC Control Power to the Reactor Trip Switchgear

Neutron Monitoring

The output of the NI Safety Drawers provide Logarithmic and Linear Power Range signals to the RPS.

Main Steam

Each Steam Generator provides two Water Level signals per channel to the PPS to be used as RPS and ESFAS bistable inputs. The SG Wide Range (WR) signals are used for the Low Steam Generator Water Level reactor trip (44.2%) and Auxiliary Feedwater Actuation System (AFAS) actuations (25.8%). The SG Narrow Range (NR) signals are used for the HI Steam Generator Water Level reactor trip and Main Steam Isolation System (MSIS) actuations.

Pressure signals from each SG are also provided as inputs. These signals are used for the Low Steam Generator Pressure reactor trip, Main Steam Isolation System (MSIS) actuations and Ruptured SG Lockout (High delta P) in the Auxiliary Feedwater Actuation System.

Reactor Coolant

The RC System provides wide and narrow range Pressurizer Pressure, and Steam Generator Differential Pressure inputs to the PPS.

The Pressurizer Pressure WR signal is used in the Low Pressurizer Pressure reactor trip as well as the Safety Injection Actuation System (SIAS) and Containment Isolation Actuation System (CIAS) actuations.

The Pressurizer Pressure NR signal is used in the High Pressurizer Pressure reactor trip.

Separate pressurizer pressure transmitters provide inputs for the Supplementary Protection System reactor trip.

The Steam Generator Differential Pressure signal is used in the Low Reactor Coolant Flow reactor trip.

Reactor Regulating System

The RRS receives a Control Element Withdrawal Prohibit (CWP) signal from the PPS to prevent withdrawal of CEAs.

COLSS

JSCALOR is used to calibrate the excore NIs

EO: 1.7 Describe the color scheme associated with PPS instrument channels.

Main Idea

The instrument channels feeding PPS are assigned colors for ease of identification. They are:

Channel A --- Red

Channel B --- Green

Channel C --- Yellow

Channel D --- Blue

EO: 1.8 Describe the PPS instrumentation monitoring excore neutron flux including its function, bases, and setpoint (as described in the Technical Specifications).

Introduction

There are four channels of safety instrumentation which provide neutron flux information from startup neutron flux levels of approximately 2×10^{-8} to 200% power (10 decades).

Main Idea

Neutron flux is monitored from source levels through full power operation, and signal outputs are provided for information and the following reactor trips:

Variable Overpower Protection (VOPT). Setpoint variable with power Provides protection against core damage during an uncontrolled CEA Withdrawal or CEA Ejection (Accident). The setpoint is 9.7% above current power and is limited to a max of 110% power. The maximum rate of power increase allowed by tech specs is 10.6%/minute**. Note that the CPC Aux trip on VOPT will trip sooner than the PPS VOPT trip as its trip ceiling does not move up as quickly.**

High logarithmic power: Setpoint > 1E-2%, Protects the integrity of the fuel cladding and helps protect the Reactor Coolant Pressure Boundary.

NOTE:

Reduced HI LOG TRIP Setpoint 1 x 10-3% Power is required if Nuclear Fuels determines there is a significant neutron flux reduction due to the core reload. These reduced setpoints are required until calorimetric compensation (36MT-9SE14 or equivalent) is performed.

Low DNBR: Setpoint < 1.34, Provides protection against core damage due to the occurrence of locally saturated conditions in the limiting (hot) channel during several transients and is the primary reactor trip (trips the reactor first) for these events.

High Linear Power Density (LPD) Setpoint > 21 kw/ft , Provides protection against fuel centerline melting due to the occurrence of excessive local power density peaks during several transients.

EO: 1.9 Describe the PPS instrumentation associated with RCS Low Flow, including its function, bases, and setpoint (as described in the Technical Specifications).

Main Idea

Four DELTA P protection channels are provided for each SG which are used to generate a low flow reactor trip for RCP sheared shaft protection.

The range of Indication range is 0-70 psid and is provided on B05 and via the PMS.(Range value is not testable)

The associated LCO requires four channels of Reactor Coolant Flow Steam Generator #1-Low and Reactor Coolant Flow Steam Generator # 2-Low to be OPERABLE in MODES 1 and 2. The Allowable Value is set low enough to allow for slight variations in reactor coolant flow during normal plant operations while providing the required protection. Tripping the reactor ensures that the resultant power to flow ratio provides adequate core cooling to maintain DNBR under the expected pressure conditions for this event.

Explanation

Note that there has been a recent (8/28/00) change to the TS required setpoint for this trip which raised the DP from 10 to 17.2. and the "floor" from 11.9 to 12.49--both changes will effect a trip a bit sooner than the former numbers. (Students are not required to recall this setpoint) See DMWO 815525/SWMS ENG WO 218788 for further information.

EO: 1.10 Describe the PPS instrumentation associated with Pressurizer Pressure - Narrow Range including its function, bases, and setpoint (as described in the Technical Specifications).

Main Idea

PT-101 A, B, C, D are the four narrow range pressurizer pressure (1500-2500 psia) instruments that measure pressurizer steam space pressure and provide inputs to the plant computer (PMS) and the PPS.

The RPS input is used to initiate a reactor trip on High pressure of 2383 psia.

Indication is provided for all channels in the main control room on B05.

The Pressurizer Pressure—High trip provides protection for the high RCS pressure SL. In conjunction with the pressurizer safety valves and the main steam safety valves (MSSVs), it provides protection against overpressurization of the RCPB during the following events:

- Loss of Condenser Vacuum (AOO)
- CEA Withdrawal From Low Power Conditions(AOO)
- Chemical and Volume Control System Malfunction (AOO) and
- Main Feedwater System Pipe Break (Accident).

EO: 1.11 Describe the PPS instrumentation associated with Pressurizer Pressure - Wide range including its function, bases, and setpoint (as described in the Technical Specifications).

Main Idea

PT-102 A, B, C, D are the four wide range (0-3000 psia) protection channels which provide inputs to the PMS and PPS. Indication of all channels is provided on B05.

The PPS input is used to initiate the Low Pressure Reactor Trip, SIAS, and CIAS at 1837 psia.

The Pressurizer Pressure—Low trip is provided to trip the reactor to assist the ESF System in the event of loss of coolant accidents (LOCAs). During a LOCA, the Safety Limits may be exceeded; however, the consequences of the accident will be acceptable. A Safety Injection Actuation Signal (SIAS) and a Containment Isolation Actuation Signal (CIAS) are initiated simultaneously. SIAS ensures acceptable consequences during large break loss of coolant accidents (LOCAs), small break LOCAs, control element assembly ejection accidents, and main steam line breaks (MSLBs) inside containment. CIAS ensures acceptable mitigating actions during large and small break LOCAs, and MSLBs either inside or outside containment, and FWLBs inside containment.

EO: 1.12 Describe the PPS instrumentation associated with Steam Generator Pressure including its function, bases, and setpoint (as described in the Technical Specifications).

Introduction

Several operators stated during the exam reviews that they believed that once an AFAS was initiated the delta-P lockout would not stop the feed to the faulted Steam Generator.

Main Idea

PT-1013 A, B, C, D (SG-1) and PT-1023 A, B, C, D (SG-2)

provide four pressure protection channel inputs to the PPS for each SG. They can be read on B05.

The pressure protection channels will initiate a Reactor trip at 960 psia and a Main Steam Isolation Signal (MSIS) at the same setpoint. The MSIS setpoint can be reduced by the operator during cooldown to allow for normal depressurization of the SGs during this evolution.

The SG pressure instruments also input to PPS to prevent AFAS from feeding a faulted SG with Auxiliary Feedwater if the pressure difference between the SGs exceeds 185 psid. In addition, the delta-P lockout will close the isolation and flow control valves, for the lowest S/G, if they are open.

The Steam Generator #1 Pressure—Low and Steam Generator #2 Pressure—Low trips provide protection against an excessive rate of heat extraction from the steam generators and resulting rapid, uncontrolled cooldown of the RCS. This trip is needed to shut down the reactor and assist the ESF System in the event of an MSLB or main feedwater line break accident. A main steam isolation signal (MSIS) is initiated simultaneously.

MSIS ensures acceptable consequences during an MSLB or FWLB (between the steam generator and the main feedwater check valve), either inside or outside containment.

EO: 1.13 Describe the PPS instrumentation associated with Wide range Steam generator Level including its function, bases, and setpoint (as described in the Technical Specifications).

Main Idea

LT-1113 A, B, C, D (SG-1) LT-1123 A, B, C, D (SG-2) are the wide range SG level instruments that feed into PPS and can be read on B05.

Output of these channels is sent to the PPS to provide a SG low level reactor trip at 44.2%.as well as Auxiliary Feed Actuation Signal at 25.8%.

The Steam Generator #1 Level—Low and Steam Generator #2 Level—Low trips ensure that a reactor trip signal is generated for several events to help prevent exceeding the design pressure of the RCS due to the loss of the heat sink.

AFAS maintains a steam generator heat sink during a steam generator tube rupture event and an MSLB or FWLB event either inside or outside containment.

Explanation

They measure level from 143 inches above the tube sheet to 55.5 inches above the moisture separator support plate, a range of 376.25 inches

EO: 1.14 Describe the PPS instrumentation associated with Containment pressure including its function, bases, and setpoint (as described in the Technical Specifications).

Main Idea

PT-351 A, B, C, D are the Containment pressure transmitters that provide inputs to the PMS and PPS. Indication of all four channels is provided on B05.

Inputs to PPS provide a Reactor trip, Safety Injection Actuation Signal (SIAS), Containment Isolation Actuation Signal (CIAS), and a Main Steam Isolation Signal (MSIS).

All these signals have a common setpoint of 3.0 psig.

The Containment Pressure—High trip prevents exceeding the containment design pressure psig during a design basis LOCA or main steam line break (MSLB) accident. During a LOCA or MSLB the SLs may be exceeded; however, the consequences of the accident will be acceptable. An SIAS, CIAS, and MSIS are initiated simultaneously.

EO: 1.15 Describe the PPS instrumentation associated with Narrow range Steam generator Level including its function, bases, and setpoint (as described in the Technical Specifications).

Main Idea

LT-1114 A, B, C, D (SG-1) LT-1124 A, B, C, D (SG-2) are the narrow range SG level transmitters that input to PPS. Indication of 0-100% level is provided on B05 for all channels.

Inputs to PPS provide a SG High level reactor trip and a Main Steam Isolation Signal at 91.0%.

The Steam Generator #1 Level—High and Steam Generator #2 Level—High trips are provided to protect the turbine from excessive moisture carryover in case of a steam generator overfill event.

Explanation

They have a range of 150 inches, beginning about 369 inches above the tube sheet (95 inches below the separator support plate). The high level taps are shared with the wide range channels.

EO: 1.16 Describe the PPS instrumentation associated with Wide range Containment pressure including its function, bases, and setpoint (as described in the Technical Specifications).

Main Idea

PT-352 A, B, C, & D are used by ESFAS to initiate a Containment Spray Actuation Signal at 8.5 psig. Indication is available on B05.

CSAS actuates containment spray, preventing containment overpressurization during large break LOCAs, small break LOCAs, and MSLBs or feedwater line breaks (FWLBs) inside containment. .

EO: 1.17 Describe the PPS instrumentation associated with RWT Level including its function, bases, and setpoint (as described in the Technical Specifications).

Main Idea

LT-203 A, B, C, and D, the RWT level transmitters, are used by ESFAS to initiate a Recirculation Actuation Signal at 7.4% and decreasing. All four channels can be read on B05.

At the end of the injection phase of a LOCA, the Refueling Water Tank (RWT) will be nearly empty. Continued cooling must be provided by the ECCS to remove decay heat. The source of water for the ECCS pumps is automatically switched to the containment recirculation sump. Switchover from RWT to containment sump must occur before the RWT empties to prevent damage to the ECCS pumps and a loss of core cooling capability. For similar reasons, switchover must not occur before there is sufficient water in the containment sump to support pump suction. Furthermore, early switchover must not occur to ensure sufficient borated water is injected from the RWT to ensure the reactor remains shut down in the recirculation mode. An RWT Level—Low signal initiates the RAS.

EO: 1.18 Describe how the PPS compares an input signal to a setpoint and generates an output if that setpoint is exceeded.

Introduction

The following material describes how bistables, comparator cards and relay cards work to achieve the ends of PPS.

Main Idea

Input signals from field instruments are compared to a setpoint via a "bistable comparator card" which can be as simple as determining whether or not the input signal is above or below a fixed value setpoint or it may be more complex with a setpoint that changes as the input process changes. The bistable comparator card will output to two (in some cases three) bistable relay cards if a trip setpoint is exceeded and those bistable relay cards will change the position of remote contacts in order to report the bistable change to PPS coincident logic, alarms, and indication appropriately.

EO: 1.19 Describe how Coincident Matrix Logic functions to cause a PPS trip.

Introduction

The following scheme description will apply to RPS as well as ESFAS actuation.

Main Idea

Tripping of a bistable results in the deenergization of bistable relays. Contacts from the bistable relays of the same parameter in the four protection channels are arranged into six logic matrices.

These matrices are designated AB, AC, AD, BC, BD, and CD and represent all possible coincidence of two channel combinations. To form a logic matrix, trip bistable relay contacts of two similar protection measurement channels are connected in parallel (e.g., variable overpower (VOPT), in Channel A and variable overpower in Channel B). Since there is more than one parameter that can initiate a reactor trip, the parallel pairs of bistable trip relay contacts for each monitored parameter are then connected in series. Cross members in the logic matrix ensure that two "like" signals (i.e., trip signals by the same parameter in two protection measurement channels) are required to interrupt power through the matrix and initiate actual reactor trip.

Under normal circumstances power flows from the two matrix power supplies down two parallel paths of series contacts to a bus bar which powers four relays. The four relays are called matrix relays and they must remain energized for the reactor to remain at power. If these relays are deenergized, contacts in another relays power supply, called an initiation relay, will open deenergizing the relay which will directly result in the opening of a trip circuit breaker and the interruption of power to the CEDMs.

The contact strings making up the coincidence matrix ladder are actually the bistable relay contacts themselves.

Thus, for example, the channel A VOPT bistable will have three bistable relays used in 2/4 logic designated A1-1, A1-2, and A1-3. The contacts for these three relays are located on the "A" side of the AB Matrix, AC Matrix and AD Matrix--the only three matrices that receive an input from A channel. The VOPT in Channel B has three bistable relays designated as B1-1, B1-2, and B1-3.

These three relays make up the "B" side of the AB Matrix, the BC Matrix and the BD Matrix.

Let’s say AB Matrix trips on HI Pressurizer pressure. This removes 12 VDC power from the Matrix Relays and lights two lamps on the BCP, one in Channel A, and one in Channel B. Tripping one channel de-energizes the associated bistable relays which in turn opens and closes the associated contacts in three matrix logics circuits causing three lamps to illuminate on the BCP beneath the trip function. The three lamps are located immediately beneath the High Pressurizer Pressure P/T/Bypass Lamps. The three red LEDs will remain on only as long as the trip is in effect. Once it clears they will go out; however, the "P" and "T" lamps above the three LEDs will remain latched on, unless the reset push-button is depressed.

EO: 1.20 Describe how matrix logic receives electrical power.

Introduction

The matrix power supplies have an interesting design to minimize the effects of a power loss.

Main Idea

Power to each logic matrix is supplied by dual dc power supplies. This power supply converts the incoming AC to DC.

Each power supply is fed from a separate 120 VAC vital distribution system bus.

All power supplies are located within the PPS cabinets and may be accessed through the rear panel doors. Matrix Power Supplies are configured so that loss of one vital instrument bus will not result in a reactor trip. If one power supply should fail, two RTSGs would open.

This is because the power supply return lines from the matrix relays are not common.

The reactor would not trip however, due to the matrix relay arrangement. Matrix relays AB-1 & AB-3 would deenergize causing RTSG #1 & #3 to open.

The AB-2 and AB-4 matrix relays would remain energized by the "B" channel power supply and the control rod drive mechanisms would continue to be supplied power through RTSG #2 & #4.

It is important to notice that each of the four vital instrument busses feeds exactly three matrices. If a single vital instrument bus were lost, three matrices would be effected and two matrix relays would deenergize in each of the three matrices. All three matrices would lose, in this case, the two matrix relays on same side (all would lose 1 and 3, or all would lose 2 and 4) , resulting in the trip of the same two RTCBs, thus a reactor trip would not occur.

The power supply arrangement that allows this is as follows:

Left side power from	Matrix	Right Side power from
PNA	AB	PNB
PNA	AC	PNB
PNA	AD	PND
PNC	BC	PNB
PNC	BD	PND
PNC	CD	PND
Loss of PNA or PNC causes 1&3 matrix relays to deenergize for all three associated matrices		Loss of PNB or PND causes 2&4 matrix relays to deenergize for all three associated matrices

EO: 1.21 Describe the interface between matrix relays and initiation circuits in the RPS.

Introduction

There are differences in the way RPS and ESFAS actuate but the basic approach using logic matrices and initiating relays are the same.

Main Idea

When the two channels monitored by given logic matrix both indicate the same parameter exceeding its trip setpoint contacts will open in the logic matrix which will cause the matrix initiation relays to deenergize. When the matrix initiation relays deenergize, corresponding contacts will open in each of four series circuits composed of similar contacts from the other matrices. Opening any of the six series contacts will cause an associated K relay to deenergize. Once the four K relays deenergize their associated contacts in the Reactor trip circuit breaker control scheme change position and the four RTCBs will trip open deenergizing the CEDMs and allowing CEAs to fall into the core.

EO: 1.22 Describe how RTCBs are tripped and what indication of trip path status is available.

Main Idea

While each RTSG is controlled by a different initiation relay (K-1 for RTSG-1, K-2 for RTSG-2, etc.), any two-out-of-four coincidence of similar bistable trips should result in deenergization of all four initiation relays and therefore, the tripping of all four RTSGs.

The RTSGs are tripped by concurrent actuation of both shunt trip (energize to trip) and undervoltage (de-energize to trip) devices upon receipt of either automatic or manual reactor trip signals.

Separate manual trip PBs are provided for each RTSG on B05. The operator trips all four when required to manually trip the reactor as some combinations of tripping only two would not provide a Reactor trip. The combinations that will not result in a trip are A&C only or B&D only. All other combinations of two or more channels will result in a full reactor trip.

Trip path status indication is provided locally, above the PPS Cabinet by two white phase current lamps which are normally illuminated, on the PPS Status Panels (C&D).

These lamps are repeated on the Remote Operators Panel in the Control Room (B05).

RTSG status is also indicated locally on the PPS Status Panels above the PPS Cabinet.

EO: 1.23 State the RTCB control power source.

Main Idea

The RPS logic matrix relays change the status of contacts in the RTCB control power scheme which is itself powered by:

RTCB 1 ------PKA

RTCB 2 ------PKB

RTCB 3 ------PKC

RTCB 4 ------PKD

EO: 1.24 Describe the RPS operating bypasses.

Introduction

Bypasses are provided to permit startup, maintenance and testing of the RPS. Visible indication of any bypass in effect is provided to the operator.

Main Idea

DNBR/LPD Bypass

The DNBR/LPD bypass defeats both the DNBR and LPD trips from the CPCs. It allows a normal reactor startup, since an abnormal CEA configuration, such as shutdown CEAs inserted, will cause DNBR and LPD trips. Each protection channel must be bypassed individually. All four channels may be bypassed simultaneously. The bypass must be manually inserted from key switches at the remote CPC modules on B05 when ex-core safety channel NI power is less than 10-4% power. The bypass will be automatically removed should ex-core NI power increase above 10-4%. It may also be manually removed.

Low Pressurizer Pressure Bypass

This bypass is provided to allow system heatup and cooldown and it defeats both the RPS trip and ESFAS actuation functions associated with low RCS pressure. It must be manually inserted on each channel and can be accomplished only when RCS pressure is below 400 psia and it is automatically removed if system pressure increases to greater than 500 psia. Bypassing and bypass removal may be accomplished from either the BCPs on the PPS cabinets, the PPS Remote Operator's Modules (ROMs) on B05, or the Remote Shutdown Panels (RSP).

High Logarithmic Power Level Bypass

The High Log Power trip bypass is provided to allow the reactor to be brought into the power range during a reactor startup. Bypassing must be done manually for each protection channel and can be accomplished from either the BCPs or ROMs.

The ex-core safety channel NI power must be above 10-4% and the bypass is automatically removed below 10-4% power. During a startup, it is important to bypass the HI Log Power trip when above 10-4%, but prior to exceeding the HI Log Power trip setpoint (10-2% power).

A HI Log Power Bypass Permissive annuniciator is on when power is above 10-4%, and HI Log Power has not been bypassed which should clear when the bypass is in effect, or if power decreases below 1 x 10-4%. This prevents annunciation when the plant is normally at power.

EO: 1.25 State the purpose of a trip channel bypass and describe its operation.

Main Idea

The trip channel bypass is provided to remove any parameter in any protection trip channel from service for maintenance or testing.

The trip logic is thus converted to a two-out-of-three bases for the trip type bypassed. Other trips remain in a two-out-of-four logic.

Trip channel bypasses function by closing contacts in parallel with the bistable output relay contacts in the logic matrix "trip ladders".

The bypass must be manually inserted and manually removed from a key locked, covered panel below the BCP on the front of the PPS cabinets.

EO: 1.26 Describe the RPS Trip Channel bypass interlock.

Main Idea

An electrical interlock prevents the operator from bypassing more than one trip channel at a time for any one type of trip.

Different type trips may be bypassed simultaneously, either in one channel or in different channels.

Attempting to insert a trip channel bypass in a second channel for the same type of trip will result in only the Highest priority channel being in bypass, with A being the highest, and D the lowest priority. If “C” channel Pressurizer pressure had tripped and was bypassed and “A” or “B” channel was subsequently bypassed, “C” would come out of bypass and trip.

EO: 1.27 Describe the RPS Power Trip Test Interlock.

Main Idea

The Power Trip Test Interlock (PTTI) will trip DNBR and LPD in the event of NI switch misalignments or voltage problems.

EO: 1.28 Describe the CPC test interlock associated with the RPS.

Main Idea

The Low DNBR and High LPD channel trips are interlocked such that both must be in the trip channel bypassed mode to initiate testing of the associated CPC channel.

EO: 1.29 Describe the Nuclear Instrument Testing interlock associated with the RPS.

Main Idea

There are several interlocks associated with testing of the safety channel NIs.

- Placing the Linear Calibration switch on the ex-core safety channel NI drawer to other than the OPERATE position will cause a channel Variable Overpower trip.
- Placing the Logarithmic Calibrate switch on the NI drawer to other than the OPERATE position will cause a channel High log power trip.

EO: 1.30 Describe the Matrix Testing Interlock associated with the RPS.

Main Idea

During PPS testing, a Test Power Interlock allows the matrix relays in only one of the six logic matrices to be tested at one time.

The same Test Power Interlock circuit also allows only one bistable input signal at a time to be perturbed.

EO: 1.31 Describe the RPS controls and indications available for the operator at B05.

Introduction

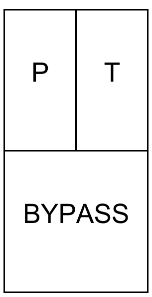
Four Remote Operator's Modules (ROM) are provided on B05, one for each protection channel.

Each ROM provides RPS and ESFAS controls and indications.

Only those controls applicable to the RPS are detailed below.

Main Idea

Bistable Status Indicators



Sixteen RPS bistable status indications are provided on each ROM (15 trip functions +1 spare).

These indicators have three back-lighted sections: P (pretrip), T (trip) and BYPASS.

All sections of all indicators are normally extinguished. If a trip, pretrip or trip channel bypass conditions exists for the monitored parameter in that channel, the white "P" section, red "T" section and/or amber "BYPASS" section will illuminate as appropriate. The pretrip and trip indicators are memory lamps - i.e., they will remain lighted, even after the trip condition clears, until they are manually reset.

Test Push-button

TEST

Depressing the TEST PB lights all three sections of the bistable status indicators on the ROM and similar indicators on the corresponding PPS cabinet BCP.

Releasing the TEST PB will extinguish only the BYPASS portion of the bistable status indicators.

Reset Push-button

RESET

Returns the white P (pretrip) and red T (trip) sections of the bistable indicators to their original state if the alarm or test condition has cleared.

Lo Pzr Press Bypass Switch

As discussed earlier, the Pressurizer pressure trips can be bypassed using this switch.

This is a three position, spring-loaded, return-to-center rotary switch. Moving the switch to the BYPASS position will initiate a low pressurizer pressure bypass in that channel if conditions allow (RCS pressure below 400 psia as indicated by the amber PERMISSIVE light). Moving the switch to the OFF position will remove the bypass. The bypass will also be removed automatically if pressure rises above 500 psia.

Three indicator lamps are provided:

- The white OFF lamp indicates no bypass.
- The amber PERMISSIVE lamp lights to indicate that RCS pressure is below 400 psia and bypass insertion is permissible.
- The red BYPASS lamp is lighted when a low pressurizer pressure bypass is in effect in that channel.

Lo Pzr Press Setpoint Reset Push-button

Depressing and releasing the PB will lower the low pressurizer pressure trip and pretrip setpoints by one step (trip setpoint to 400 psia below existing RCS pressure). After a 10 second interval, depressing the PB again will cause a similar setpoint reduction.

On raising Pressurizer pressure, setpoint pressure will lag existing system pressure by a fixed increment of 400 psi until the ceiling setpoint of 1837 psia is reached. However, once a trip occurs, the setpoint cannot be reset until pressure again rises above the setpoint at which the trip occurred.

Hi Log Power Bypass Switch

This is a three position, spring-loaded, return-to-center rotary switch. Moving the switch to the BYPASS position will initiate a HI Log Power Bypass in that channel if conditions allow (when power is above 10-4% as indicated by the amber PERMISSIVE light). Moving the switch to the OFF position will remove the bypass. The bypass will also be removed automatically when power drops below 10-4%.

Three indicator lamps are provided:

- The <u>white OFF lamp</u> indicates no bypass.
- The <u>amber PERMISSIVE lamp</u> lights to indicate when power is above 10-4% and bypass insertion is permissible.
- The <u>red BYPASS lamp</u> is lighted when a low HI Log Power bypass is in effect in that channel.

Lo SG Pressure Reset Push-button

Ask students to describe function as review--discussed earlier

Depressing and releasing this guarded, momentary PB will decrement the SG-1 and SG-2 low pressure trip and pretrip setpoints by one step (trip setpoint to 200 psia below existing SG Pressure).

As with the low pressurizer pressure setpoint reset PB, 10 seconds must elapse before additional setpoint reductions can be effected.

RTSG Phase Current Indicator

These white lamps at the bottom of the Channel C and D ROMs are normally on to indicate current flow to the CEDMs.

Initiation Relay Status Monitors

Status lamps are provided for one RPS and seven ESFAS initiation relays on each PPS ROM.
All lamps are normally illuminated.

A lamp will be extinguished when its associated initiation circuit has been opened and initiation relay de-energized.

The lamps on the Channel A ROM monitors status of the number 1 initiation circuits.
Initiation circuits 2, 3 and 4 are monitored by the Channel B, C and D ROMs respectively.

EO: 1.32 Describe the RPS controls and indications available to the operator at the PPS status panels.

Introduction

The PPS Status Panels are mounted directly above the front of the corresponding PPS Cabinets.

Main Idea

Trip Path Indicators for RPS and ESFAS

A single indicator lamp provides the operator with RPS status in each trip path.

The lamps are color coded to correspond to their appropriate PPS channels (A-red, B-green, C-yellow, D-blue). The lamps are normally on. They will be extinguished when the RPS initiation circuit (Trip Path) is actuated in the corresponding channel.

RTSG Position

Status lamps (red-closed, green-open) are provided below the RPS trip path status lamps. RTSG-1, 2, 3 and 4 status is given on the channel A, B, C and D panels respectively.

Phase Current Lamps

The channel C and D panels have white CEDMCS phase current status lamps.

EO: 1.33 Describe the RPS controls and indications available to the operator at the Bistable Control Panel.

Introduction

A separate BCP is provided for each of the four RPS measurement channels. They are located on the front of the PPS cabinet, behind a locked, see-through door. Each BCP is provided with the following RPS controls and indications.

Main Idea

A Digital Voltmeter (DVM)

A range of 0 +19.999 volts is provided for use in conjunction with the meter input select switch.

Meter Input Select Switch

This is an eight position rotary switch. Only seven of the positions are used. Switch positions and the functions performed in each are as follows:

Position	Function
OFF	All meter inputs are disconnected.
EXT DVM	DC voltages from external sources can be input to the DVM through the EXT DVM jacks adjacent to the meter input select switch
INPUT	Selects the input of the selected bistable comparator to the DVM. This may be either the normal input voltage or the test voltage for the selected bistable if testing is in progress
Pretrip SP	Displays the pretrip setpoint of the selected bistable
Trip SP	Displays the selected bistable comparator’s trip SP voltage
NI	Connects the selected signal from the associated NI safety channel drawer to the DVM
VSP	Used for variable SP card testing

DVM + 10 V Push-button

Depressing this PB provides a +10 Vdc reference voltage to the DVM for calibration check.

DVM Zero Push-button

Provides a zero volt reference for DVM calibration check.

DVM - 10V Push-button

Provides a -10 Vdc reference for DVM calibration check.

Bistable Select Switches

Two sixteen position rotary switches are provided. When the first switch is taken out of OFF and placed in any position from 1 through 14, the selected bistable input (parameter input or test), pretrip and trip setpoint voltages are connected through the DVM meter input select switch and displayed on the DVM. In position 15, bistable selection is transferred to the second BISTABLE SELECT switch for comparator circuits 15 through 30 (not all positions are used).

Channel Test Push-button

This is a guarded, alternate action PB indicator. When depressed, the indicator is back-lighted and testing circuits for the particular channel are energized. Only one channel can be placed in test at one time. The four CHANNEL TEST switches are prioritized in channel A-B-C-D order.

Other Bistable Control Panel Switches and Indications

The following Switches and Indications are the same as on B05:

- Lo Pzr Press Bypass Switch
- Low Pressurizer Pressure Bypass Indicators
- Lo Pzr Press Setpoint Reset Push-button
- Hi Log Power Bypass Switch
- HI Log Power Bypass Indicators
- LO SG Pressure Reset Push-button
- Bistable Status Indicators

CPC/CWP Indicator Lamp

A single green CPC/CWP indicator is provided on each BCP. The lamp is normally on. It will be extinguished when a CWP input has been generated by a CPC pretrip (DNBR or LPD) in that channel.

Bistable Relay Status Indicators

These red lamps are trip indicators and, as such, are normally extinguished. They are identified by system (RPS or ESFAS), matrix and parameter. A red indicator is lighted only if the appropriate bistable output relay is de-energized as a result of a bistable trip of the corresponding parameter in that channel. Since each bistable acts on three matrices(considering just RPS), there are three lights provided(For example, “A” channel inputs to AB; AC; and AD matrices. When a particular bistable trips, those three lamps should light indicated the bistable relays have deenergized.

The lamps extinguish when the trip clears. If a coincidence between channels (valid trip) occurs, only the lamps closest to the top of the matrix (furthest to the left on the BCP) will be illuminated.

This is because a coincidence condition removes all downstream power from the matrix, deenergizing matrix relays, but also inhibiting downstream lamps, even if other trips are present.

EO: 1.34 Describe the RPS controls and indications available to the operator at the Trip and Pretrip setpoint potentiometer Panel.

Introduction

The Trip And Pretrip Setpoint Potentiometer Panel

is located behind the key locked hinged cover on the lower section of the BCP. The following controls are located on this panel:

Main Idea

Trip And Pretrip Setpoint Potentiometers

These potentiometers are used for adjustment of the pretrip and trip setpoints for the bistable comparator cards. Either setpoint may be displayed on the BCP DVM using the meter input select and BISTABLE SELECT switches.

Some parameters (bistable numbers 1, 6, 11, 12, 14 and 15) use variable trip and pretrip setpoints. For these specific circuits, the TRIP SETPOINT potentiometers determine the maximum trip setpoint voltage (trip ceiling) that can be generated by the VSP card.

The PRETRIP SETPOINT potentiometers determine the voltage difference between the VSP card trip and pretrip outputs.

Trip Channel Bypass Pushbuttons

Previously discussed RPS bistable bypass is performed using these pushbuttons which latch in place when depressed. The bypass switches will function even if they are used to bypass a bistable relay associated with a deenergized matrix power supply. For example if PNA is deenergized, the “A” side power of the AB matrix is lost. If all of the bypass pushbuttons for the deenergized bistable relays are pushed, a subsequent trip of a “B” side bistable will NOT cause a Reactor trip. Power from the “B” side of the matrix will simply bypass the tripped “B” side bistable via the “A” side bistable relay bypass--because it latches in place.

EO: 1.35 Describe the RPS controls and indications available to the operator at the Matrix Test Module.

Introduction

The following information is presented for completeness of information on RPS controls and not required material as I&C is responsible for testing the matrices.

Main Idea

Matrix Test Module

Six Matrix Test Modules (MTMs) are provided - one for each coincidence logic matrix. They are mounted on the front of the PPS cabinet immediately below the BCPs. The controls and indications located in each MTM are functionally identical.

Relay Hold Switch

Selecting this switch to Hold makes test power available to the appropriate relays of the matrix to be tested (provided test power has first been applied via the BCP-mounted CHANNEL TEST switch). Selecting the switch to Trip will deenergize the relay selected by the Relay Trip Switch.

Relay Trip Switch

This is an eight position, rotary select switch. In any of the four numbered positions, only the indicated matrix relay will not receive holding power when the RELAY HOLD TEST Switch is selected to trip during matrix testing. This one matrix relay will, therefore, be allowed to drop out, interrupting the current flow through the corresponding trip path (initiation circuit), deenergizing the K relay and opening the associated RTSG.

Sys Chan Trip

The system channel trip selector is a 12 position rotary switch. It permits selection of either the RPS or any of the ESFAS actuation functions for testing.

RPS Chan Trip

This 20 position rotary switch permits selection of any specific RPS parameter for testing.

Its use is enabled by first setting the SYS CHAN TRIP selector to RPS. With a particular parameter selected and the RELAY HOLD Switch selected to trip, the two corresponding bistable output relays which provide contact inputs to the logic matrix being tested will receive "bucking" current to their test coils. This causes the bistable relays to move to their de-energized (tripped) position and opens the coincidence matrix. In this way, proper operation of the logic matrices can be verified for all input parameters without actually tripping a bistable. Hold power is also simultaneously applied to the matrix relays to prevent the matrix relay contacts from opening the trip paths and initiating a reactor trip during testing.

Matrix Indicator Lamps

These red lamps provide status indication of all matrix relays for both RPS and ESFAS functions.

All matrix relays will normally be energized and all MATRIX status lamps will normally be energized and all MATRIX indicators will be extinguished when its associated matrix relay is de-energized.

Hold 1, 2, 3, 4 Indicator Lamps

These red indicator lamps are normally extinguished. They will light when holding power is being applied to the matrix relay test coils.

Drop Out 1, 2, 3, 4 Indicator Lamps

These red lamps are also normally extinguished. They will be lighted during matrix testing when the appropriate matrix relay is in its de-energized (tripped) position. With a matrix relay in its tripped position, a trip path (initiation circuit) is also opened and, if the K-relay has functioned properly, a RTSG has tripped.

EO: 1.36 Describe the RPS controls and indications available to the operator at the Initiation Reset Panels.

Introduction

The four Initiation Reset Panels are located adjacent to the locked front panel door on each PPS cabinet bay.

Main Idea

Each panel contains an amber indicator labeled INITIATION RESET, six push-button switches and a rotary key-lock switch.

Initiation Reset Indicator

Flashes to indicate the existence of an ESFAS function trip in the associated cabinet bay or the associated RTSG is open.

Key-Lock Switch

When placed to the UNLK position, arms the six push-button reset switches.

When In LK, the function of the reset PBs are defeated.

Reset Pushbuttons

Provided for RPS and all ESF functions except Auxiliary Feedwater Actuation (AFAS).

Depressing the RPS reset PB will close the associated RTSG (if the trip condition has cleared).

EO: 1.37 Describe the RPS indications available to the operator relating to the following auxiliary functions:

- **Relay Card Rack**
- **Cabinet Cooler Assembly Controls**
- **Power Supply Panels**

Introduction

PPS has several auxiliary functions that are discussed here--the student will not be held responsible for this objective--it is presented for completeness.

Main Idea

Relay Card Rack

The relay card racks are located at the bottom of the PPS cabinets.

On the face of the relay card rack is a red GROUND DETECTION light emitting diode (LED) indicator, which will extinguish when a ground fault has been identified in that cabinet bay.

Cabinet Cooler Assembly Controls

Mounted beneath the relay card racks in each PPS cabinet bay are two blower assemblies to provide cooling for that bay. Each blower has an ON-OFF switch.

Power Supply Panels

Power to each bay of the PPS Cabinet is provided from a separate Class 1E Instrument Bus.

Within each bay, the input is differentiated into 15 power supplies. All power supplies are fused. Self-indicating (blow fuse) fuse-holders are provided for each power supply. Red LED indicators below the fuses are illuminated by the output voltage of each power supply. Access to the power supplies is via the rear panel doors of the PPS Cabinet.

EO: 1.38 Describe the RPS related controls and indications located at the Remote Shutdown Panel.

Introduction

Four PPS modules are provided on the RSP - one for each protection channel.

Main Idea

Each module contains the following controls and indications which are duplicated on B05:

- Low Pressurizer Press Bypass Switch
- Low Pressurizer Pressure Bypass Permissive Indicators
- Low SG Press Reset Switch
- Low PZR Press Reset Switch

Each module contains the following additional controls and indications

- Low PZR Press Pretrip Indicator---A red lamp indicates low pressurizer pressure pretrip actuation on the associated PPS channel.
- Low SG Press Pretrip Indicator --A red lamp indicates RPS pretrip on low pressure in either SG.

EO: 1.39 Describe the RPS controls and indications available to the operator at the Reactor Trip First Hit Alarm Panel.

Introduction

The RPS First Hit panel provides a good, though not infallible indicator of the parameter that caused a reactor trip.

Main Idea

The first RPS Trip parameter that makes up the two out of four logic will be the only parameter in fast flash. Other windows may light up, but the fast flash will be the first trip that makes up the trip logic.

The first hit light can indicate the wrong parameter because a channel bypassed with a trip will still send its logic signal to the plant monitoring computer indicating that channel has a trip and if another single channel of the same parameter trips the alarm logic will be satisfied and the First Hit window will fast flash but the reactor will not be tripped.

EO: 1.40 Describe how ESFAS initiation differs from RPS actuation and draw a functional diagram of ESFAS.

Main Idea

Both RPS and ESFAS are similar in that they both employ:

- Trip Generation
- Matrix Logic
- Initiation Logic
- Actuation Logic

Each PPS channel receives a separate input from its associated sensor for each parameter monitored.

When both inputs to a logic matrix are received, the matrix sends trip signals, via its matrix relays, to each of four initiation circuits and the initiation circuits then cause system actuation.

There is an important difference:

When ESFAS initiation circuits deenergize they open contacts in redundant Aux Relay Cabinets (ARCs). Those open contacts deenergize relays resulting in actuation of the associated safety related equipment.

Your drawing should include:

- Typical field inputs
- Logic matrices
- Matrix relays
- Initiation relay contacts
- Trip Circuit breakers for RPS (including shunt and UV coils)
- Aux relay cabinets for ESFAS

The level of detail for the drawing should demonstrate your understanding of how PPS causes ESFAS equipment to actuate when trip setpoints are exceeded.

EO: 1.41 Describe what automatically initiates the Safety Initiation Actuation System (SIAS) and its function.

Introduction

Safety Initiation Actuation Signal (SIAS) can be manually initiated from B05 or will initiate as follows:

Main Idea

A SIAS is generated by:

- Low Pressurizer Pressure of 1837 Psia (Ceiling-Variable Setpoint)
- High Containment Pressure of 3.0 Psig.

Pretrip alarms are provided to alert the operator that a trip value is being approached.

SIAS ensures acceptable consequences during large and small break LOCAs, CEA ejection accidents and main steam line breaks inside of containment.

SIAS initiates the Emergency Core cooling system and performs several other functions such as initiating Control room filtration, starting diesel generators, and stopping Normal Containment Cooling fans.

EO: 1.42 Describe what automatically initiates the Containment Isolation Actuation System (CIAS) and its function.

Introduction

Containment Isolation Actuation Signal (CIAS) can be manually initiated, or will automatically initiate as follows:

Main Idea

A CIAS is generated on either:

- Low Pressurizer Pressure of 1837 Psia (Ceiling-Variable Setpoint)
- High Containment Pressure of 3.0 Psig

A SIAS, CIAS and reactor trip will occur simultaneously.

Pretrip alarms are provided.

The CIAS initiates isolation of selected process lines penetrating the containment.

EO: 1.43 Describe what automatically initiates the Containment Spray Actuation System (CSAS) and its function.

Introduction

The Containment Spray Actuation System (CSAS) may be manually initiated or will automatically initiate as follows:

Main Idea

A CSAS is generated on a HI-HI containment pressure of 8.5 psig.

Since CSAS occurs at a higher containment pressure than the SIAS & CIAS actuations, both SIAS & CIAS should also be present during any containment spray actuation. Pretrip alarms are provided.

The CSAS actuates the Containment Spray Systems in the event of a LOCA or MSLB and is necessary to ensure Containment pressure does not exceed design.

EO: 1.44 Describe what will automatically initiate a Recirculation Actuation Signal (RAS) and its function.

Introduction

Recirculation Actuation Signal (RAS) is the only ESFAS signal that should never be initiated before set point is reached.

RAS can be manually initiated but will automatically initiate when:

Main Idea

A RAS is generated on a low Refueling Water Tank (RWT) level of 7.4%. Pretrip alarms are provided.

The RAS is provided to initiate recirculation of borated water from the containment sump by opening Containment sump suctions to SI pumps, tripping operating LPSIs and closing SI pump RWT recirc valves to avoid contamination of the RWT.

EO: 1.45 Describe what will automatically initiate a Main Steam Isolation Signal (MSIS) and its function.

Introduction

MSIS can be manually initiated but will auto initiate when:

Main Idea

A MSIS is generated when any of the following conditions occur:

- A low SG No. 1 or SG No. 2 pressure of 960 psia (ceiling - variable setpoint)
- A high level in SG No. 1 or SG No. 2 of 91% (NR)
- A high Containment Pressure of 3.0 psig.

All inputs are shared with the corresponding RPS reactor trips. Pretrip alarms are provided for all inputs.

The MSIS will isolate the Main Steam, Main Feedwater, Sample and Blowdown lines on both steam generators regardless of which SG (if either) was responsible for the actuation.

EO: 1.46 Describe what automatically initiates Auxiliary Feedwater Actuation Signal (AFAS) and its function.

Introduction

The Auxiliary Feedwater Actuation Signal (AFAS) can be manually initiated or will auto initiate when:

Main Idea

Separate AFAS signals are developed for each Steam Generator: AFAS-1 for SG-1 and AFAS-2 for SG-2.

An AFAS is initiated for a particular steam generator when it has:

A low level of 25.8% WR and its pressure is **not** 185 psid below the other Steam Generator.

The SG pressure instrumentation channels are compared in the AFAS circuitry. As long as pressures in both SGs are about equal, both will be considered intact. If, however, pressure in the two SGs differs by more than 185 psi, the one with the lower pressure will be considered FAULTED and will not receive an AFAS actuation. If a faulted SG is being fed by AFAS when >185 psid is reached AFW will be isolated to the faulted generator.

Pretrip alarms are provided.

Once actuated, the auxiliary feedwater pumps will remain operating until the actuation has been reset and the pumps manually secured.

The actuated valves will cycle open and shut automatically to maintain level in the appropriate SG.

- Open at 25.8% WR
- Close at 40.8% WR

Each aux. feedwater train can feed either SG individually or both SGs simultaneously.

EO: 1.47 Describe how the AFAS lockout functions to block AFAS.

Introduction

While the bistable output relay contacts are normally used directly for development of the logic matrices, those associated with AFAS actuations differ and require special attention.

Main Idea

If a low level is sensed in either steam generator and the pressure differential between steam generators is not greater than 185 psid AFAS will initiate for the affected SG.

If low level is accompanied by a High DELTA P, the driver for the SG with the lower pressure will be held in the energized state, preventing AFAS actuation on that steam generator.

EO: 1.48 Describe how ESFAS signals are manually initiated by the operator.

Introduction

It is vitally important to understand how ESFAS is manually initiated.

Main Idea

Manual initiation of both the A and B safety equipment trains for SIAS, CIAS, CSAS, MSIS, RAS, AFAS-1, and AFAS-2 is accomplished from B05, using **all four** actuation switches. Certain combinations will not result in an actuation. They are A&C alone or B&D alone. All other combinations of two or more channels will result in a full actuation of both trains.

These switches open the trip path lock-outs once actuated. Manual actuation of individual safety equipment trains for each actuation signal can be done from the Aux. Relay Cabinets.

Manual actuation of the MSIS (both trains) can also be accomplished from the Remote Shutdown Panel.

EO: 1.49 Describe the ESFAS Initiation Logic Circuits and their function.

Introduction

As with RPS, four initiation circuits are used for each ESFAS actuation signal and each circuit contains six contacts in series, one from a matrix relay in each of the six coincidence matrices. De-energizing a single matrix relay will open the circuit and initiate an actuation signal from the initiation relays.

Main Idea

Each ESFAS initiation circuit, unlike RPS, contains two initiation relays.

There are two trains (A and B) of ESF equipment and the same initiation circuit provides actuation signals to both trains.

Each ESFAS initiation circuit (except AFAS-1 and AFAS-2) contains a "lockout" relay in parallel with the initiation relays. The initiation circuit has, once it has been de-energized, will remain in the tripped or actuated state until the key-locked Initiation reset button has been pushed, restoring power to the Initiation and lockout relays which ensures the post-accident status of all ESF-actuated components is maintained even after the initiating signal has cleared.

Lockouts circuits as described immediately above are not provided for the AFAS-1 and AFAS-2 actuations, as the AFAS valves are allowed to cycle in order to control SG level.

The AFAS Subgroup Relay lockout circuits differ from other ESFAS circuits in that the paralleled Interposing Relay is not in series with the Lockout Reset Switch and, therefore, will be re-energized as soon as the PPS Trip Initiation Relay is energized.

EO: 1.50 Describe the purpose of the Auxiliary Relay Cabinets.

Introduction

Two identical Auxiliary Relay Cabinets are provided as an interface between the PPS cabinet and the Plant ESF System equipment--one for “A” side equipment and one for “B” side equipment.

Main Idea

The Aux relay cabinets house indication and controls that inform the operator of the status of the various ESFAS subsystems and allow the operator to manually actuate and reset the subsystems.

EO: 1.51 Describe the ESFAS Aux Relay Cabinet actuation and lockout relay arrangement for CIAS, CSAS, MSIS, RAS, and SIAS.

Introduction

Each actuation relay is responsible for the operation of one or more ESF components.

Main Idea

The actuation relays located in the Aux. Relay Cabinets are typically separated into a pump group and a valve group for each actuation signal.

When deenergized, each actuation relay will cause its particular component(s) to assume its ESF position or condition.

Lockout relays are provided in the Aux. Relay Cabinets as well which ensures that deliberate operator action is required to remove the ESFAS signal from actuated components.

There are two lockout relays in each ARC for each actuation signal - one for each power flowpath to the actuation relays and only one of the two need be depressed to reset an ESFAS actuation once the ESFAS initiating signal has cleared.

EO: 1.52 Describe how an ESFAS subsystem can be manually actuated and manually reset from the Aux Relay Cabinets.

Main Idea

The operator can manually initiate an ESFAS subsystem by depressing both of the associated trip pushbuttons. The pushbuttons must be depressed simultaneously because both parallel power legs, 1-3 and 2-4, must be interrupted at the same time to deenergize the actuation relays.

Only one reset pushbutton needs to be depressed to reset the system as powering the actuation relays momentarily will reenergize the lockout relay and close contacts in both power legs to restore power from both sides.

EO: 1.53 Describe the actuation and lockout relay arrangement associated with AFAS/DAFAS.

Introduction

There are two separate AFAS Actuation signals, AFAS-1 and AFAS-2:

AFAS-1 starts both AFAS pumps and cycles only the valves to feed Steam Generator 1 and AFAS-2 starts the same pumps and cycles only the valves which feed Steam Generator 2.

AFAS-1 and AFAS-2 each have two separate trains, AFAS-1 Train A and Train B, and AFAS-2 Train A and Train B.

Main Idea

While the ARC lockout relays typically de-energize both the pump and the valve group actuation relays, the AFAS is an exception in that only the pump group relays are affected by the lockout.

The valve groups for AFAS actuations are not locked-out and are able to cycle open and closed to maintain the proper steam generator level.

In Train A (ARC A), trip paths 1 and 2 open contacts (1A and 2A) in series with AFAS valve 1A1 and 2A1 actuation relays (flow path from Pump A to SG #1). Since there are no lockout relays on these legs, the valves will cycle on water level, opening at 25.8%, and closing when water level rises to 40.8% wide range level.

These same valve actuation relays also open contacts in series with the Pump Group actuation relays.

These pump group relays do lockout once de-energized by the valve actuation relays, resulting in the pumps remaining on once actuated.

Maintained-contact handswitches are required in AFAS actuation, rather than the spring return switches used in other ESFAS functions because there are no auxiliary feedwater valve lockout relays in the AFAS Trip Paths so if spring return switches were used, the auxiliary feedwater valves would shut as soon as they were released. With AFAS switches, the valves remain open as long as the switches are actuated and it is therefore possible to overfeed a SG when AFAS is manually actuated.

Example 1:

If an AFAS actuation was manually initiated using the handswitches on B05, at 35% WR (prior to the automatic setpoint) the valves would stay open until the handswitches are returned to normal.

If the handswitches are cycled from normal to actuate and returned to normal, the valves would close until level decreased to the 25.8% WR setpoint and the valves would stay open until the SG level raises up to 40.8% WR.

AFAS differs from other ESFAS actuations in another respect.

In other ESFAS functions, Trains A and B are identical in implementation.

Only the components actuated by the actuation relays differ. In the case of AFAS the trip path contacts are switched between Trains A and B.

In Train B, it is trip paths 3 and 4 (contacts 3B and 4B) which operate the valves (1B1 and 2B1). Trip Paths 1 and 2 will start the Train B pump.

This reversal between trains is necessary so that manual actuation from either set of AFAS handswitches on B05 (which open the trip paths) will actuate at least one train whereas: in other ESFAS functions, both trains are actuated if either switch set is used.

Referring again to the AFAS/DAFAS diagram in your Simplified Control System Diagram Book note that if both Trains of AFAS were identical to Train A, for example, then handswitches 1 and 2 would actuate both trains fully, but handswitches 3 and 4 would start the pumps, but the feedwater valves would not cycle.

By switching the contact between Train A and B, handswitches 1 and 2 will start both pumps (A and B) and open valves 1A1 and 2A1, thus fully initiating Train A.

Handswitches 3 and 4 will start both pumps, but only open feedwater valves 1B1 and 2B1. Thus, handswitches three and four actuate all of Train B.

<u>Proper manual actuation of AFAS is to use all four manual handswitches.</u>

Once AFAS has been actuated, the valves can be overridden to maintain feed as necessary.

EO: 1.54 Describe the ESFAS controls and indications available for the operator at B05.

Introduction

Four Remote Operator's Modules (ROM) are provided on B05, one for each protection channel. Each ROM provides RPS and ESFAS controls and indications. Only those controls applicable to ESFAS only are detailed below as common features have already been detailed.

Main Idea

Four modules are provided to allow the operator to manually initiate any Engineered Safety Function (ESF) function. Each module contains five spring-return-to-neutral handswitches and two AFAS maintained-contact handswitches. (AFAS-1, AFAS-2, CIAS, CSAS, MSIS, RAS & SIAS).

Modules A, B, C and D will de-energize initiation circuits 1, 2, 3 and 4 respectively in a selective two-out-of-four logic.

All four switches should be used when manually initiating a safety actuation signal.

EO: 1.55 Describe the indications available on the PPS status panels.

Introduction

The PPS status panels are mounted directly above the front of the corresponding PPS Cabinets.

Main Idea

The ESFAS portion of the status panel contains lamps identical to those provided on the ROMs for monitoring of initiation circuit relay status. Like those on the ROM, the lamps are normally on and will go out when the associated initiation relay is de-energized.

Immediately below each lamp on the CHANNEL A and CHANNEL B panels are two-out-of-four selective logic status monitors. Each is a split window, back-lighted indicator. The upper portion is labeled "1-3" and the lower portion labeled "2-4". All sections of all windows should normally be on. A light will go out only when current flow through the associated leg of the Aux. Relay Cabinet selective logic path has been interrupted. Both portions of the window should be extinguished when an actuation exists.

The CHANNEL A lamps monitor status of the actuation circuits for the A safety equipment train. CHANNEL B monitors safety equipment train B.

EO: 1.56 Describe the ESFAS controls available to the operator at the Bistable Control Panel.

Introduction

Some additional controls not previously addressed during the RPS Bistable Control Panel discussion are provided exclusively for ESFAS.

Main Idea

AFAS-1 and AFAS-2 Logic Test

These are the AFAS-1 and AFAS-2 test toggle switches on the upper portion of the BCP. Two switches are provided for each AFAS actuation, each having two positions.

When the SG-1(2) DELTA P switch is positioned upward, a test signal simulating actuation of the HI SG-1(2) DELTA P bistable is forwarded to the AFAS-1(2) bistable relays.

Similarly, the SG-1 (2) RUP toggle switch simulates rupture (low level and High DELTA P) for the associated steam generator.

These switches are used during PPS testing to ensure that an AFAS signal will be effectively blocked if it is determined that a steam generator has failed (Faulted).

EO: 1.57 Describe the controls and indications associated with the Auxiliary Relay Cabinets.

Introduction

Inside the center doors (bays 6 and 7) on the front of each ARC are two control panels.

As discussed, each panel houses controls for separate trip legs of the ARC actuation circuit along with the following:

Main Idea

Each ESFAS actuation signal is provided with the following controls and indications:

- Power Circuit Breaker
  Each circuit breaker establishes (or interrupts) power to a single leg of the parallel power flow path to the actuation relays.

- Blown Fuse Indication
  These indicators illuminate when a fuse is blown, indicating loss of power to the actuation circuit leg. If both fuses were to blow out neither fuse blown indication would be lit due to the absence of power from the other side of the circuit to provide this indication.

- On Indication
  These LEDs indicate the trip legs are energized.

- Lockout Reset Pushbuttons
  These momentary action PBs are used to reset the actuation circuit lockout relays.

- Manual Trip Pushbuttons
  These PBs manually actuate individual safety equipment trains for a particular ESFAS function. Each PB opens a separate leg of the ARC actuation circuit. To manually initiate a SIAS for ESF train A components, for example, the SIAS MANUAL TRIP PBs on both control panels must be depressed simultaneously.

- Bypass Test Indicators
  Red LEDs for each actuation signal energize to indicate the particular ESFAS actuation circuit has been connected to the test power supply

EO: 1.58 Describe the purpose of the Aux Relay Test Cabinet and general test methodology.

Introduction

The ARC Test Panel is mounted in ARC Bay 5 and provides the controls needed for testing ESFAS. 36ST-9SA01, performed by operations, provides the necessary guidance.

Main Idea

Testing procedures, controls and circuits are coordinated so that actual operation of each ESF component is verified without initiating either a complete isolation of the containment, injection of borated water into the RCS or initiating containment spray.

Additional test relays allow testing to ensure that no leakage current path exists between the various actuation circuits which could prevent the actuation relays from assuming their de-energized position upon receipt of an initiation signal.

Explanation

TCS 95-1330 is covered in this objective.

EO: 1.59 Describe the Supplementary Protection System including its function, instrumentation, bases, and setpoint (as described in the Technical Requirements Manual).

Introduction

The Supplementary Protection System will trip the reactor independently of the RPS.

Main Idea

The SPS trips on high Pressurizer pressure. The TRM requires a reactor trip when the SPS senses a pressurizer pressure of > 2414 psia. This trip helps to assure the integrity of the RCS during the over-pressurization involving a loss of all feedwater event coincident with an Anticipated Transient Without Scram (ATWS) event.

PT-199 A, B, C, D ---four additional narrow range (1500 - 2500 psia) PZR pressure instruments are used to provide inputs to the SPS. These instruments can be read on B05.

Each SPS channel will trip its associated RTSG so not all combinations of two channels tripping will result in a reactor trip.

When Pzr pressure reaches the setpoint on selected 2 of 4 channels (any combination of 2 except for A and C or B and D), the trip of the associated RTSGs and the opening of the MG set output contactors will result in a reactor trip independent of RPS action. No pretrip alarms are provided.

SPS has no direct manual trip capability but the RTSG can be locally tripped.

EO: 1.60 Describe the output functions of the Supplementary Protection System initiation relays.

Introduction

The initiation relay is powered by 24 VDC. With SPLA power ON, and the system in a normal (not tripped) condition, the Initiation Relay is energized.

Main Idea

The initiation relay controls one B contact in the RTSG shunt trip coil, and one A contact in the RTSG under-voltage trip coil. Another A contact is provided to the SPLA isolation panel for actuation of relays which supply signals to the Motor-Generator control panels, actuate status lights and supply a SPLA Trip annunciate signal.

A trip condition or a power failure, deenergizes the relay and operates the contacts above.

The SPLA TRIP annuniciator signal also interfaces with the Diverse Auxiliary Feedwater Actuation System (DAFAS) and serves as a permissive signal for DAFAS initiation.

Red and Green indication lights provide indication of whether an open signal has been provided to the M-G set output load contactors in the M-G Set Control Panels.

EO: 1.61 Describe the Diverse Aux Feedwater Actuation System (DAFAS) including its function, methodology, and setpoint (as described in the Technical Requirements Manual).

Introduction

DAFAS is designed to respond to an ATWS condition with a failure of the AFAS system to actuate.

DAFAS is interesting in that it is not required by Technical Specifications or the TRM, but is required by 10CFR50. The reason for DAFAS' omission from Tech Specs is that it is not considered in our Safety Analysis and is therefore not required to be addressed.

Main Idea

DAFAS will initiate if an SPS signal is generated and SG levels are < 20.3% WR with no MSIS or AFAS signal present.

DAFAS is designed to address the unique situation that an ATWS has occurred with a loss of feedwater and a failure of AFAS to actuate. MSIS prevents or terminates a DAFAS actuation in order to prevent feeding a faulted generator.

The two channels of DAFAS, DAFAS-A and DAFAS-B, each have two programmable logic controllers. A1 and A2 are the designated PLCs for DAFAS A and B1 and B2 are the designated PLCs for Channel B. Each PLC requires two of four SG Wide Range level signals to drop below 20.3 % with a coincident SPS trip signal to give the PLC a trip output. The channel then requires a two of two logic of the PLCs to trip. Remember that A1, for example, only operates a leg 1-3 contact so A2 must actuate as well to interrupt power to the 2-4 leg in order to cause an actuation.

All DAFAS circuitry is energized to actuate in a manner diverse from the normal AFAS in order to provide independent backup.

Each channel (A or B) consist of one train located in one cabinet.

- Each cabinet contains one set of two Programmable Logic Cards A1 & A2 are in Channel A cabinet and B1 & B2 are in Channel B cabinet

- Each individual channel can actuate an AFAS to either Steam Generator using both trains of equipment. (DAFAS A, for example can actuate AFAS 1 or AFAS-2 in Train A and B ESFAS ARCs.)

- One(1) PLC Programmable Logic Card can trip one leg of the actuation logic circuit for either AFAS-1 or AFAS-2 in both A and B Aux Relay Cabinets. The relays are energize to actuate DAFAS.

Notice that a single PLC (A1, A2, B1, or B2) cannot cause or prevent an AFAS actuation nor can one channel cause only a single train of Auxiliary Feed equipment to actuate.

Any two of the four SG levels reaching the trip setpoint of 20.3 % will satisfy the SG level portion of the logic for that PLC.

All four Channels of SPS are fed to all four PLCs for determination of whether an ATWS exists. If SPS has not actuated the PLC will not pass a signal to cause AFAS actuation regardless of SG level.

DAFAS Outputs

Each PLC is associated with a specific trip leg of the ESFAS ARC for AFAS 1 and AFAS 2. Specifically PLCs A1 and B1 are associated with leg 1-3 and PLCs A2 and B2 are associated with leg 2-4

Both legs (1-3) & (2-4) of the actuation circuit needs to be opened to cause an actuation and each PLC can send a signal to AFAS 1 A and B or AFAS 2 A and B associated trip leg contacts.

When DAFAS reset is reached at > 40.5% WR or MSIS occurs the DAFAS relays become de-energized. As with any AFAS actuation, the inner trip leg of the ESFAS Actuation Circuit remains de-energized due to the lockout contacts.

DAFAS Bypass

The function of the bypass is to prevent the DAFAS signal from actuating the contacts in the trip legs of the ARCs.

To take DAFAS out of service then you must bypass both trip legs of both trains of DAFAS.

It takes 8 keys to bypass DAFAS. The key switches are located in ESFAS ARC 5 & 8.

With the bypass relays energized a contact is closed in parallel with the DAFAS contact such that the opening of the DAFAS contact will have no effect.

An annunciator 5B11C A Train DAFAS in test, bypass or system failure will alarm. See ARP for guidance.

Explanation

TCS 93-1842 Incorporate note on DAFAS Keys (CRDR 080254) credited to this objective.

EO: 1.62 State the LCOs associated with the Reactor Protection System Logics and Manual Initiation, including their bases.

Introduction

This objective requires knowledge of how this system impacts Technical Specifications.

Main Idea

LCO 3.3.4 Six channels of RPS Matrix Logic, four channels of RPS Initiation Logic, four channels of reactor trip circuit breakers (RTCBs), and four channels of Manual Trip shall be OPERABLE.

APPLICABILITY: MODES 1 and 2

MODES 3, 4, and 5, with any RTCBs closed and any control element assemblies capable of being withdrawn.

Bases:

The RPS Logic provides for automatic trip initiation to maintain the SLs during AOOs and assist the ESF systems in ensuring acceptable consequences during accidents. All transients and accidents that call for a reactor trip assume the RPS Logic is functioning as designed.

All of the transient and accident analyses that call for a reactor trip assume that the RTCBs operate and interrupt power to the CEDMs.

There are no accident analyses that take credit for the Manual Trip; however, the Manual Trip is part of the RPS circuitry. It is used by the operator to shut down the reactor whenever any parameter is rapidly trending toward its trip setpoint. A Manual Trip accomplishes the same results as any one of the automatic trip Functions.

EO: 1.63 State the LCOs associated with the Reactor Protection System, including their bases.

Introduction

This objective requires knowledge of how this system impacts Technical Specifications.

Main Idea

LCO 3.3.1 Four RPS trip and bypass removal channels for each Function in Table 3.3.1-1 shall be OPERABLE.

APPLICABILITY: According to Table 3.3.1-1.

1. Variable Over Power
2. Logarithmic Power Level—High
3. Pressurizer Pressure—High
4. Pressurizer Pressure—Low
5. Containment Pressure—High
6. Steam Generator #1 Pressure—Low
7. Steam Generator #2 Pressure—Low
8. Steam Generator#1 Level—Low
9. Steam Generator#2 Level—Low
10. Steam Generator #1 Level—High
11. Steam Generator #2 Level—High
12. Reactor Coolant Flow, Steam Generator #1-Low
13. Reactor Coolant Flow, Steam Generator #2-Low
14. Local Power Density—High
15. Departure From Nucleate Boiling Ratio (DNBR)—Low

BASES: The bases for these trips, along with the actuating setpoints, are addressed in the instrumentation section of this handout.

Table 3.3.2-1 gives the RPS requirements when the plant is shutdown:

- Logarithmic Power Level-High
- Steam Generator #1 Pressure-Low
- Steam Generator #2 Pressure-Low

The bases for the shutdown trips were not discussed earlier and are presented here:

The Logarithmic Power Level - High trip protects the integrity of the fuel cladding and helps protect the RCPB in the event of an unplanned criticality from a shutdown condition.

The Steam Generator Pressure - Low trip function provides shutdown margin to prevent or minimize the return to power, following a large Main Steam Line Break (MSLB) in MODE 3.

EO: 1.64 State the LCOs associated with the Engineered Safety Features Actuation System (ESFAS) including their bases.

Introduction

This objective requires knowledge of how this system impacts Technical Specifications.

Main Idea

LCO 3.3.5 Four ESFAS trip and bypass removal channels for each Function in Table 3.3.5-1 shall be OPERABLE.

APPLICABILITY: According to Table 3.3.5-1 as follows:

1. Safety Injection Actuation Signal--in Modes 1,2 and 3
   a. Containment Pressure—High
   b. Pressurizer Pressure—Low

2. Containment Spray Actuation Signal--in Modes 1,2 and 3
   a. Containment Pressure—High High

3. Containment Isolation Actuation Signal in Modes 1,2 and 3
   a. Containment Pressure—High
   b. Pressurizer Pressure—Low

4. Main Steam Isolation Signal -- in Modes 1,2 and 3
   a. Steam Generator #1 Pressure—Low
   b. Steam Generator #2 Pressure—Low
   c. Steam Generator #1 Level-High
   d. Steam Generator #2 Level-High
   e. Containment Pressure-High

5. Recirculation Actuation Signal--in Modes 1,2 and 3
   a. Refueling Water Storage Tank Level—Low

6. Auxiliary Feedwater Actuation SignalSG#1 (AFAS-1) -- in Modes 1,2 and 3
    a. Steam Generator #1 Level—Low
    b. SG Pressure Difference—High

7. Auxiliary Feedwater Actuation SignalSG#2 (AFAS-2) -- in Modes 1,2 and 3
    a. Steam Generator #2 Level—Low
    b. SG Pressure Difference—High

The bases for these have already been discussed in the instrumentation section.

EO: 1.65 State the LCO associated with the Engineered Safety Feature Actuation Logics and Manual Initiation, including its basis.

Introduction

This objective requires knowledge of how this system impacts Technical Specifications.

Main Idea

LCO 3.3.6 Six channels of ESFAS Matrix Logic, four channels of ESFAS Initiation Logic, two channels of Actuation Logic, and four channels of Manual Trip shall be OPERABLE for each Function in Table 3.3.6-1. The basis is the same as the basis for the logics and manuals of RPS.

Table 3.3.6-1 is summarized here.

1. Safety Injection Actuation Signal
   a. Matrix Logic Modes 1,2,3
   b. Initiation Logic Modes 1,2,3, and 4
   c. Actuation Logic Modes 1,2,3, and 4
   d. Manual Trip Modes 1,2,3, and 4

2. Containment Isolation Actuation Signal
   a. Matrix Logic Modes 1,2,3
   b. Initiation Logic Modes 1,2,3, and 4
   c. Actuation Logic Modes 1,2,3, and 4
   d. Manual Trip Modes 1,2,3, and 4.

3. Recirculation Actuation Signal
   a. Matrix Logic Modes 1,2,3
   b. Initiation Logic Modes 1,2,3, and 4
   c. Actuation Logic Modes 1,2,3, and 4
   d. Manual Trip Modes 1,2,3, and 4

4. Containment Spray Actuation Signal
   a. Matrix Logic Modes 1,2, and 3
   b. Initiation Logic Modes 1,2, and 3
   c. Actuation Logic Modes 1,2, and 3
   d. Manual Trip Modes 1,2, and 3

5. Main Steam Isolation Signal(a)
   a. Matrix Logic Modes 1,2, and 3
   b. Initiation Logic Modes 1,2, and 3
   c. Actuation Logic Modes 1,2, and 3
   d. Manual Trip Modes 1,2, and 3

6. Auxiliary Feedwater Actuation Signal SG#1 (AFAS-1)
   a. Matrix Logic Modes 1,2, and 3
   b. Initiation Logic Modes 1,2, and 3
   c. Actuation Logic Modes 1,2, and 3
   d. Manual Trip Modes 1,2, and 3

7. Auxiliary Feedwater Actuation Signal SG#2 (AFAS-2)
   a. Matrix Logic Modes 1,2, and 3
   b. Initiation Logic Modes 1,2, and 3
   c. Actuation Logic Modes 1,2, and 3
   d. Manual Trip Modes 1,2, and 3

EO: 1.66 Describe the alarms associated with the Plant Protection System including their cause and designated operator actions.

Introduction

The following B05 alarms are associated with PPS.

Main Idea

Annunciator	Description
HI **PZR PRESS** **CH** **TRIP** *Red*	This annunciator is typical of many such on B05. Every parameter measured for the purpose of producing a trip of RPS or ESFAS has a similar window indicating that the parameter has exceeded its trip setpoint. Note that any of the four channels reaching the trip setpoint will cause this tile to alarm.
HI **PZR PRESS** **CH** **PRE TRIP** *Green*	This annunciator is also typical of many such on B05. Every parameter measured for the purpose of producing a trip of RPS or ESFAS has a similar window indicating that the parameter has exceeded its pre-trip setpoint. Pretrips are designed to alert the operator of an impending channel trip. Note that any of the four channels reaching the pretrip setpoint will cause this tile to alarm.

LO **PZR PRESS** **OPER** **BYPASS** *Red*	This alarm is an indication that the operator manually bypassed the Low Pressurizer Pressure Trip. This can only be done below *400 psia*. The bypass is removed by the circuitry when pressure rises above *500 psia.* Any channel being placed in bypass will bring in this alarm.
HI LOG **PWR LVL** **BYP** **PERM** *White*	Actuates circuitry to allow manual bypassing of the Hi Log Power trips and pre-trips when reactor power level is greater than *l0 -4 %* neutron rated thermal power. The Hi Log Power trip and pre-trip bypasses are automatically removed when logarithmic power level decreases below *l0 -4 %* neutron rated thermal power. This alarm indicates that at least 1 channel is above the necessary setpoint.
SPS **CH** **TRIP** *Green*	This tile alarms when any of the four Supplementary Protection System channels exceeds its trip setpoint.
SPS **TEST** *White*	This alarm is brought in for 2 reasons: • Individual SPS cabinet door open • Test Enable Switch left in the enable position

DNBR/LPD **OPER** **BYPASS** *White*	This alarm is received when the key-operated Trip Bypass switches at the Core Protection Calculator System Operator's Modules on B05 are taken to bypass for the DNBR and Local Power Density trips and pre-trips. Any single channel Trip Bypass switch will bring in this alarm.
RPS **INIT** *Green*	Any single RPS channel trip will bring in this alarm.
LEG 1-3 **SIAS** **A** **LEG 2-4** *Red*	This annunciator is typical of many such on B05 because every ESFAS has a similar window. The window is divided into an upper and lower section. The upper section will illuminate if Leg 1-3 deenergizes and the lower section will illuminate if Leg 2-4 deenergizes. If both sections are illuminated the associated ESFAS will have actuated. If only a single section of the alarm tile is illuminated no action will have occurred.
ESFAS **AUX RELAY** **SYS** **TRBL** *White*	Possible causes of the alarm and possible indications include: Failed power supplies in bay 5, 6, 7 or 8 of the ESFAS auxiliary relay cabinet as indicated by a deenergized LED indicators located on each power supply. Tripped power supply breakers located locally at each power supply in bay 5, 6, 7 or 8 or grounded power supply outputs in bay 5 or 8 could also be the cause.

DIVERSE **AFAS** **A** **TRIP** *Green*	This annunciator alarms when DAFAS A has exceeded its trip setpoint and satisfied its trip logic. There is a similar annunciator for DAFAS B.
DIVERSE **AFAS** **A** **TST/TRBL** *White*	If channel A is in test or a system failure exists this alarm will annunciate. It should be noted that placing DAFAS in "bypass" will not bring this alarm in and will not prevent this alarm from annunciating for any valid test signal or malfunction. There is a similar alarm for B DAFAS.
PPS **TRBL/GND** *White*	This annunciator response is very informative in that it lists all the 60 individual power supplies associated with PPS and describes how to diagnose power supply failures. Should a power supply fail the alarm response will aid the operator in determining what particular function of PPS has been affected for the purpose of Tech Spec review. I&C involvement will be needed to trouble shoot and repair.
PPS **IN** **TEST** *White*	Possible causes of the alarm include: • Front or rear panel door open on a Plant Protective System cabinet. • A channel test switch in the test position on the bistable control panel in a Plant Protective System cabinet, as indicated by a lit Channel Test pushbutton switch.

Annunciator	Description
PPS **CH** **BYP** *Amber*	This alarm will annunciate whenever a PPS channel is placed in bypass at bistable control panel on plant protective system cabinet. The alarm may also be caused by a failed auxiliary relay in relay card rack portion of plant protective system cabinet.
SIAS *Red*	This is a typical annunciator for any ESFAS or BOP-ESFAS initiation. The alarm will annunciate when an actuation has occurred. Either train A or train B actuating will cause this window to alarm. The alarms for all actuations are located on a single bar toward the bottom of the BO5 alarm windows.

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 student 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.

Training Material Review Checklist

NKASYC014903	Plant Protection System
Document #	Title

D. Horn	05/06/10	Jim Ledford	05/06/10
Author	Date	Reviewer	Date

Check each item listed below on the training material.

✔ 1. Document number and title are correct.

✔ 2. Duration of course / lesson is indicated.

✔ 3. Training material revision date and author is complete.

✔ 4. Training material has a technical review and approval signatures, if needed.

✔ 5. Initiating documents are listed which require the training to be developed.

✔ 6. Procedures used in the development of the course are listed.

✔ 7. Required Topics list documents which have commitments to train on and the topics are contained in the training material.

✔ 8. TCS items are incorporated and are listed.

✔ 9. Content References used in the development of the course are listed.

✔ 10. Tasks are referenced to the current task list or references to VISION database are indicated.

✔ 11. The terminal objective(s) is(are) listed with conditions, performance, and standards.

✔ 12. The objectives are listed and sequenced to ensure prerequisite knowledge and skills are acquired prior to more advanced items.

✔ 13. Introduction section includes student attention, and introductory lesson business.

✔ 14. The objectives are noted to coincide with the content and activities.

✔ 15. Training material content reflects latest revisions of procedures, drawings, and vendor technical manuals.

✔ 16. The training material content is sufficient to support the objectives.

✔ 17. The training material sequence is logical and instructionally appropriate.

✔ 18. The training material has methods and activities listed, as appropriate.

✔ 19. Industry operating experiences format satisfies the following questions:

- What happened? (Event description and factors affecting the event).
- Why did it happen? (Root cause, follow-up investigations, and corrective actions taken, if applicable).
- Can it happen at Palo Verde? (Significance to our plant).
- What can we do to mitigate an event if it did happen? (Preventive measures or barriers in place at our site).

Training Material Review Checklist

✔ 20. The summary section reviews key lesson points.

✔ 21. New material is not presented in the summary.

✔ 22. Prevent Event tools and methods are incorporated into training material to support Palo Verde and Line strategies.

☐ 23. At least one enabling objective in a continuing training course has a behavior or standard that includes management standards and expectations, error reduction techniques, or industrial safety.

✔ 24. If a training lesson plan addresses a major safety system or component, part of the lesson plan should include the basis for that system or component. (CRAI 3063012)

✔ 25. Review lesson plan for fundamental theory applications as well as probabilistic risk assessment as appropriate. (CRAI 3319750)

Operations Only

☐ 1. Ensure revised lesson plans for NLIT includes system normal, start-up, shut down, abnormal and emergency operations if applicable. (TSCAI item 338907)

✔ 2. Ensure system lesson plans contain information on Time Critical Actions per 40DP-9ZZ04 if applicable.