PALO VERDE
NUCLEAR GENERATING STATION

Valve Services

Classroom Lesson

Valve Services	**Date: 08/11/2004**
LP Number: NMV21P000102	**Rev Author: Robin Meredith**
Title: Air Operated Valve Calibration	**Technical Review: Randy Croxton**
Duration : 40 Hours	
	Teaching Approval:

INITIATING DOCUMENTS:

Maintenance Training Program Description

REQUIRED TOPICS

NONE

CONTENT REFERENCES

30MT-9ZZ22 Calibration of Control Valves

VTM F130 Fisher Controls

VTM M430 Moore Components

OE 13263 Near Miss with AOV

OE 17438 Mechanic injured during AOV Maintenance

OE 13479 Mechanic Injured During Valve Disassembly

Lesson Plan Revision Data

Aug 10, 2004 Robin Meredith Updated course to add additional instrumentation.

Tasks and Topics Covered

The following tasks are covered in Air Operated Valve Calibration:

Task or Topic Number*	**Task Statement**
Lesson:	Air Operated Valve Calibration
VS 2110	Calibrate Air Operated valve Positioner
VS 2120	Calibrate Diaphragm Actuated valve
VS 2150	Maintain Air Operated Valve Accessories

Total tasks or topics: 3

TERMINAL OBJECTIVE:

1.1 Given the necessary references, tools and test equipment,, the technician will maintain pneumatic control valve components. Mastery will be demonstrated by completion of all Laboratory Practical Evaluations and scoring at least 80 % on an end of course exam.

1.1.1 Given an example or illustration, identify the types of control valves.

1.1.2 Given an example or illustration, identify components associated with various valve types.

1.1.3 Identify flow characteristics of various valves .

1.1.4 Describe the operation of Pneumatic Actuators

1.1.5 Describe the critical elements associated with valve packing.

1.1.6 Describe the operation of a flapper/nozzle detector.

1.1.7 Calibrate Valve Positioners.

1.1.8 Describe the operation of a booster relay.

1.1.9 Describe the operation of an air regulator

1.1.10 Describe the operation of valve position indication devices.

1.1.11 Describe the use and operation of solenoid valves on air operated valves.

1.1.12 Calibrate a Fisher 546 I/P Converter.

1.1.13 Benchset diaphragm actuators.

1.1.14 Calibrate a Steam Bypass Control Valve.

Lesson Introduction: Air Operated Valve Calibration

The following items are things to consider in your Lesson Introduction. They are not mandatory. You should develop your own introduction and place that material in the Program Hierarchy in the Lesson Introduction Tab or appropriate Training Unit.

CLASSROOM GUIDELINES

- If applicable, remind students of class guidelines as posted in the classroom.
- Pass the attendance sheet around and have it signed in Dark ink.
- Ensure that student materials needed for the class are available for each student.
- Emphasize student participation and remind them of your philosophy on asking and answering questions, if applicable.

ATTENTION STEP

- Give a brief statement or story to get student concentration focused on the lesson subject matter.

LESSON INTRODUCTION

- Give a brief statement that introduces the specific lesson topic. Should be limited to a single statement.

MOTIVATION

- Focus student's attention on the benefits they derive from the training. At Instructor's discretion. The need for motivation in each succeeding lesson must be analyzed by the Instructor and presented as necessary.
- Instructor should include how the STAR process can be used to improve or enhance Operator Performance, if applicable.
- Read and discuss lesson terminal objective and review lesson enabling objectives, if desired.
- If applicable, briefly preview the lesson topic outline and introduce the major points to be covered. The objective review may have been sufficient.
- REINFORCE the following PVNGS management expectations as opportunities become available
  - Nuclear Safety
  - Industrial Safety Practices
  - STAR and Self-Checking
  - Procedure Compliance
  - Communication Standards
  - ALARA
  - Prevent Events

Use the 5 Questions to prevent events as an introduction to the course.

What is the task and do I understand it?
Training on Air Operated Valve Calibration
•Benchset
•Positioners
•Accessories

What is the worst thing that can happen and how can I prevent it?
Have the students discuss the hazards associate with Air Operated Valve Maintenance.
•Springs
•Pinch Hazards - valve motion
•Air Pressure
Discuss methods to prevent injury
•Safety Glasses

What else can happen?
Impact on the plant from operation / improper operation when on-line.

What are Safety and or Radiation Protection concerns?
When we are performing a demonstration - Training Phase, the students and instructor will wear safety glasses when dealing with pressurized air.

When the students are practicing or performing an evaluation, the students will be required to wear standard PPE. Hard Hat and Safety Glasses with hearing protection and gloves available.

Training and Qualifications
This course has no prerequisites. There are corequisites / prerequisites for the work assignment of AOV Calibration.

EO 1.1.1	**Given an example or illustration, identify the types of control valves.**

1.1.1.1 Main Idea

	Methods and Activities
Globe	Slide 5
Named for the globular shape of the body	
Flow makes two 90° changes in direction as it passes through the valve (e.g. enter horizontal, turn vertical, back horizontal)	
Flow ***usually*** goes up	
Most common type of valve for controlling a process	
Various types of globe valves will be discussed in the ‘construction’ section.	
Gate	Slide 6
A disk (gate) is lifted to allow flow through the pipe	
Typically wedge-shaped for tighter shut-off when closed	
May include a small bypass port to equalize pressure to assist opening.	
Typically used for On/Off situations	
Butterfly	Slide 7
Disk rotates inside pipe to turn flow on or off	
High flow, low pressure drop	
Check	Slide 8
Flow only allowed in one direction through the valve	

	Methods and Activities
Typically provide reverse-flow prevention (e.g. pump discharge)	
Some valves are enhanced to allow testing for freedom of movement or provided with spring assist to help keep closed.	
Diaphragm	Slide 9
A rubber diaphragm is pressed against a ridge in the bottom of the valve body to shut off flow	
Often used in chemical processes, slurries, or those with particulate or more viscous process	
Ball (V-Notch)	Slide 10
A ball has a hole drilled through it. The body is a hollow sphere, enclosing the ball	
Highest flow, least pressure drop.	
When hole lines up with pipe, flow established	
Good for viscous processes. The ball simply ‘cuts off’ any process material when it closes against the seat	
Original ball valves were mostly on-off applications. Later developments modified the contour of the hole in the ball with a ‘v-notch’ for improved flow characteristics	
Plug	Slide 11
This type is similar to the ball valve, but a conical section is used instead of a ball. It also provides high flow with a low-pressure drop. It is also good for viscous processes and slurries.	

EO 1.1.2	Given an example or illustration, identify components associated with various valve types.

1.1.2.1 Main Idea

Methods and Activities

Globe Valve Construction — Slide12

Valve Body

2-way

3-way (two seats)

Typical in temperature control applications.

Used to divert flow from on port to the other

Bonnet

Packing Flange

Packing

Valve Stem

Valve Plug — Slide 13

Seat

Cage

Cage provides guide for plug to ensure proper contact with the seat

Cage also provides the major method of characterizing the impact the valve has on the process (more later)

Trim.

	Methods and Activities
Combination of cage, plug, seat, and stem used for process characterization	
'Characterization' fulfills any of several functions:	
Flow control by valve position (more later)	
Control extreme pressure drops (e.g. pump minimum flow to condenser)	
Noise reduction.	
Results in better control of high energy processes and mitigates damage from erosion	
Ports	Slide 14
Single port valves	
Use one port (hole) to control process	
All valves discussed to this point are single port	
Pressure is applied to one side of the disk. Full dP when valve is closed.	
Double port	
Applies pressure to two sides of a double plug (two seats)	
When closed, dP is balanced (up and down at the same time)	
Less energy required to open valve.	

Valve Action

Direct (down to close)

Reverse (down to open)

Gate Valve Construction Slide 15

Valve Body

Bonnet

Packing Flange

Packing

Valve Stem

Valve Disc

Solid Disc is simplest

Split discs are forced outward when closed for a tighter seal

Seat

Manufacturer Specific Enhancements (Split disks, wedges, etc)

Butterfly Valve Construction Slide 16

Valve Body

Packing Flange

Packing

Bearings

Valve Stem

Valve Disc

Seat

Manufacturer Specific Enhancements (eccentric disks, special seats, etc)

Ball Valve Construction Slide 17

Valve Body

Packing Flange

Packing

Bonnet

Bearings

Valve Stem

Ball

Seat

Manufacturer Specific Enhancements (V-Notch, linings, etc)

EO 1.1.3	Identify flow characteristics of various valves .

1.1.3.1 Main Idea

Methods and Activities

Valve Flow Characteristics — Slide 18

General — Slides 19 / 20 / 21

Valves are categorized by how flow is affected by changing the disc / plug position while pressure drop remains constant

Linear: flow rate is directly proportional to position (25% flow at 25% open, 50% flow at 50% open, etc.)

Equal Percentage *changes* a specific amount of flow for equal percentage changes in position.

Quick opening: flow rate changes the most when the valve first starts to open. The first 40% open changes flow by about 70%. The final 40% changes flow about 12%

Based on Valve Body Type

Quick Opening valves:

Gate

Check

Equal Percentage valve types:

Butterfly

V-Notch Ball

Linear valve types:

Plug

Methods and Activities

Diaphragm

Globe valves vary widely, and the flow characteristics will be determined by the trim installed (plug and cage)

The manufacturers will identify the flow characteristics for trim they supply.

Plug and Seat cross-section shape can characterize flow.

The shape of the opening in the cage can also characterize the flow through the valve

EO 1.1.4	**Describe the operation of Pneumatic Actuators**

1.1.4.1 Main Idea

Methods and Activities

Diaphragm Actuators — Slide 22

Show the components of both air to open and air to close diaphragm actuators.

Diaphragm Casing

Diaphragm

Diaphragm Plate

Seal Bushing (Air to open only)

Actuator Stem

Spring

Spring Seat

Spring Adjuster

Stem Connector

Yoke

Travel Indicator Disk

Indicator Scale

Operation

Air to Open

Methods and Activities

Air is applied to the bottom of the diaphragm. This develops force on the actuator stem. This moves the actuator stem upward, opening the valve. When the air is removed, the spring pushes on the spring seat. This pushes the actuator stem down closing the valve.

Air to Close

Air is applied to the top of the diaphragm. This develops force on the actuator stem. This moves the actuator stem downward, closing the valve. When the air is removed, the spring pushes on the spring seat. This pushes the actuator stem up opening the valve.

Piston

Slide 23

Show the components of a piston actuator.

Upper Seal Bushing

Cylinder

Piston/Rod

Lower Seal Bushing

Yoke

Operation

Air Pressure is applied to both sides of the piston. When valve motion is desired, the air pressure is increased on one side of the piston causing the piston to reposition. Once the valve reaches the desired position, the air pressure is balanced. This holds the valve in the desired position. Some pistons have springs installed to allow the valve to move to a desired position upon loss of air.

Methods and Activities

Bettis Piston Actuators

Slide 24

Show the components of the Bettis piston actuator.

Cylinder Head

Piston

Spring

Scotch-Yoke

Output Shaft

Operation

These actuators use a Scotch-Yoke to convert the travel of the piston into rotary motion.

The air is applied to one side of the piston. This overcomes spring tension and causes the actuator stem to move. As air pressure is removed, the spring moves the stem to the failed position. These are generally used on 90º rotary applications.

EO 1.1.5	Describe the critical elements associated with valve packing.

1.1.5.1 Main Idea

Methods and Activities

General

Slide 25

The packing prevents the process from escaping along the valve stem

Too tight – and the actuator won't be able to move the valve

Too loose – and steam, acid, or whatever is all over the floor (and you)

Packing material

Braided Graphite (rope) or Carbon Composite Rings

Normally on top and bottom of packing

Acts as wiper for die-formed packing.

Die-formed Graphite Rings

Provides sealing along valve stem

Normally packing load is three rings between two ropes.

Carbon Sleeve

Used as a spacer

Normally on the bottom of the packing box

Packing configuration and orientation

Carbon Sleeve

Methods and Activities

On the bottom of the packing box

Cut to length

Carbon spacer with the packing are the same length as the stuffing box is deep

Ends cut smoothly and square

Pre-drilled holes in the edge should face up

Braided Ring or Composite Ring on top of carbon spacer

Three die-formed Graphite Rings

Final braided ring or composite ring (should be even with top of packing box)

Packing load

Packing gland/follower on top of packing

Alternate tightening gland nuts until desired load is achieved

EO 1.1.6	Describe the operation of a flapper/nozzle detector.

1.1.6.1 Main Idea

Methods and Activities

Definition

Slide 26

Flapper - a restriction to the air flow produced by the nozzle

Nozzle - Small tube with restriction designed to direct air flow toward flapper

Some form used in most pneumatic instruments to convert motion to air pressure.

Description

Two air restriction device

Supply line restriction smaller than the nozzle

Output is taken from the nozzle back pressure compartment

Nozzle back pressure determined by baffle/nozzle clearance.

Because the supply restriction is smaller than the nozzle, the nozzle back pressure compartment has a pressure proportional to the flapper position.

3-15 psig is used for most pneumatic signals because of the linear relationship of the nozzle/flapper over the range.

The major limitation of this detector is the small volume of output air due to the small size of the supply air restriction.

EO 1.1.7	Calibrate Valve Positioners.

1.1.7.1 Main Idea

	Methods and Activities
Fisher model 3582 Valve Positioner (Diaphragm Actuators with pressure input)	Slide 27

Three pressure gauges on casing

Supply

Instrument (Input)

Output

Principles of operation

Input sensed though input bellows.

As the air pressure increase, the bellows expands.

The expansion of the bellows acts on the ‘D” shaped beam.

As the beam is pushed out by the bellows, the flapper moves closer to the nozzle.

The nozzle backpressure increases

The backpressure increase is fed through a booster relay to increase the volume of the air signal.

As the air pressure increases, the actuator will move.

The actuator motion is fed back to the positioner through a lever and cam assembly.

As the actuator moves, the D-beam will reposition, balancing the instrument.

Methods and Activities

Adjustments — Slide 28

Zero adjustment is made by adjusting the initial flapper-nozzle clearance.

Span (100% Travel) adjustment is made by changing the angle of the adjustment arm.

Common Wear Points — Slide 29

Model 3582i is similar but receives a 4-20 mA current signal rather than a 3-15# pressure signal

Fisher Model 3570 (Piston actuators) — Slide 30

Description.

Piston actuated valves have air supplied to both the top and bottom of the cylinder

Uses two separate relays

One supplies the top of the piston

The other supplies the bottom of the piston

Three pressure gages

Instrument signal in

Top of piston

Bottom of piston

Operation

Input signal is sent to the input bellows

As the pressure increases,the bellows expands and moves the beam

The beam pivots around a fixed pivot point

Methods and Activities

The beam acts as the flapper for both of the relays

As the beam moves closer to one relay it is moved away from the other relay.

The movement of the beam increases the the pressure in the relay for the bottom of the piston while reducing the pressure in the relay for the top of the piston

This unbalance in the actuator will push the piston upward.

As the piston moves upward the spring tension from the range spring to the beam

As the tension decreases, the beam would move to an equilibrium position for the flapper/nozzles.

Adjustments — Slide 31

Zero - The bias spring - Establishes the initial flapper / nozzle clearances

Span - Range Spring - Sets the full travel of the positioner

Nozzle adjustments - Balance Adjustment - Sets the steady state positioner output.

With the valve at an intermediate position, the output pressures from the two relays should be approximately equal (within 5 psig) and approximately 75 % of supply pressure.

Other Positioners used at PVNGS include the following

Fisher Digital Positioners – Feedwater Control Valves

Bailey – Steam Bypass Control Valves

Moore 74 – Atmospheric Dump Valves

Methods and Activities

Valtek – MRS Drain Valves

Lab Activities

Reinforce PPE Requirements stated in Lesson Introduction

EO 1.1.8	Describe the operation of a booster relay.

1.1.8.1 Main Idea

	Methods and Activities
Booster relays are used to increase the volume of a pneumatic air signal. A flapper nozzle assembly will maintain a small volume to improve responsiveness.	Slide 32

Components

Casing

Supply port

Control Port

Outlet Port

Valve Seat

Valve Plunger

Valve Spring

Retaining Nut

Diaphragm

Operation

Supply air is applied to the chamber bellow the valve plunger.

The Spring keep the valve closed.

The control signal is applied to the top of the diaphragm.

As the control signal increases, the valve is pushed down opening the valve.

Methods and Activities

Air flows through the valve to the oultet.

The bottom of the diaphragm is subject to the outlet pressure.

If the surface area of the diaphragm is the same on both sides the oulet pressure will balance at the control pressure

Some booster relays will have different surface areas on the top and bottom to allow a 3-15# signal to control a higher pressure signal.

EO 1.1.9	Describe the operation of an air regulator

1.1.9.1 Main Idea

	Methods and Activities
A regulator operates similarly to a booster relay.	Slide 33

The major difference is that instead of a control signal on top of the diaphragm, a spring is adjusted to provide the downward force.

The output pressure must increase until the the upward force on the diaphragm matches the downward force of the spring.

Regulator Setting Guidelines

Appendix “A” of drawing 01-J-ZZI-006 provides guidance for setting regulators.

Regulator Rebuild

- 67AR
- 67AFR
- 67CFR

EO 1.1.10	Describe the operation of valve position indication devices.

1.1.10.1 Main Idea

Methods and Activities

Valve Limit Switches

Slide 34

- Indications
  - Red light – valve open
  - Green light – valve shut
  - Both lights – valve intermediate
- Operation
  - Generally two switches per valve
  - Open switch
    - Closed from the time the valve leaves the open seat until approximately 95% open
    - Power being supplied to the green light during this valve stroke
  - Closed switch
    - Closed from the time the valve is approximately 5% open 100% open
    - Power being supplied to the red light during this valve stroke
  - Intermediate position
    - Between 5% and 95%
    - Power being supplied to both lights
- Two Basic Types of limit switches
  - Lever actuated (Namco Snap-Lock)
  - Rotary, Cam Operated

Methods and Activities

Valve Position Indicators

Slide 35

Linear Variable Differential Transformer (LVDT)

Linear Variable Differential Transformers (LVDTs) are simple instruments which accurately measure small changes in position. Two coils are mounted concentrically. The center coil is the primary, excited by low voltage AC. The outer coil is center-tapped, and connected so the induced voltage in the two halves oppose each other.

A magnetic rod is positioned axially inside the coils. When the rod is in the center, the opposing voltages balance, and the output is null. When the rod moves away from center, the induced voltage in the coil toward the movement increases, while the other coil voltage decreases.

The change in output voltage is linearly proportional to the distance from the magnet to the center of the primary coil. The polarity of the output is dependent on the direction of movement. The unit is calibrated by varying the valve position and verifying the output.

EO 1.1.11	Describe the use and operation of solenoid valves on air operated valves.

1.1.11.1 Main Idea

Methods and Activities

General — Slide 36

Solenoids are generally used to supply or vent air to open-closed diaphragm actuators.

The solenoid valves discussed here have electrical operators. When the coil is energized, the armature is pulled up into the coil. This, in turn, changes the position of the valve plug. When de-energized, a spring returns the plug to the shelf-state position. Coils are typically 120 VAC or 130 VDC.

2-way are basic open-closed valves (typically energize to open).

3-way have a common port, which typically has the air supply or signal connected. The common is connected to one of the other ports, depending on weather or not the coil is energized.

4-way solenoid valves have 4 ports (e.g. A, B, C, and D). Two ports are connected when de-energized (e.g. A to C and B to D). The ports swap when energized (e.g. A to B and C to D).

The 3-way is most common, and will be covered for the remainder of this discussion.

Identify the components of a solenoid valve — Slide 37

Cover

Yoke

Coil

Methods and Activities

Housing

Solenoid Base

Core Assembly

Body

Disk Assembly

End Cap

EO 1.1.12	Calibrate a Fisher 546 I/P Converter.

1.1.12.1 Main Idea

	Methods and Activities
Operation	Slide 38
Input current is applied to the torque motor coil. Increasing current will twist the armature slightly clockwise, closing off the nozzle more.	
As nozzle pressure increases, the feedback bellows expands to balance out the armature-nozzle position, and the input pressure to the relay increases.	
The relay produces the output pressure signal which is proportional to the balance nozzle pressure. The relay provides a boost in volume to the valve positioner or actuator diaphragm.	
Adjustments	Slide 39
Zero	
Span	
Lab Activities	Reinforce PPE Requirements stated in Lesson Introduction

EO 1.1.13	Benchset diaphragm actuators.

1.1.13.1 Main Idea

Methods and Activities

Bench Set / Calibration

Use Procedure 30MT-9ZZ22 to walk through the benchset of a diaphragm actuator.

Go through the definitions of:

Bench set

Valve Stroke

Positive Set

Cycle

Hand Jack

Read Through the Precautions

Point out the following highlights as the benchset is being demonstrated.

Stress safety associated with the energy stored in a compressed spring.

Upper actuator stop is always the starting point for the benchset.

Discuss how the benchset value is adjusted.

Importance of positive seat

		Methods and Activities
	Importance of stroke length	
	Installation of positioner @50% valve travel to prevent angularity errors.	
Lab Activities		Reinforce PPE Requirements stated in Lesson Introduction

EO 1.1.14	Calibrate a Steam Bypass Control Valve.

1.1.14.1 Main Idea

Methods and Activities

The Steam Bypass Control Valve

Air Signals - there are three air signals that will be discussed as far as what it does on the SBCV.

Permissive Signal — Slide 40

Permissive satisfied - Solenoid Energizes, Closes the two Ross valves the were holding the valve shut, and opens two Ross valves that allow the modulate signal from the positioner to pass.

Modulate Signal — Slide41

Control signal is sent to the positioner. The positioner sends signals to the booster relays. The booster relays are 1:1. The signal from the positioner controls the pressure discharged to the cylinder.

Quick Open — Slide 42

The quick open signal from the SBCS will energize the quick open solenoid. The solenoid valve opens and admits air to the two large Ross valves. The Ross valve on the top will vent the top of the piston, and the Ross valve on the bottom will admit air to the bottom of the piston forcing the valve open.

Actuator Events

OE13263 Fitzpatrick 10/23/2001

Air Operated Valve was scheduled for overhaul due to seat leakage.

Regulator and tubing removed

Technician connected 3/8 inch air line from Instrument Air Header to actuator without regulator.

Methods and Activities

Technician cracked open valve.

Technician leaned over to inspect valve drainage.

In approximately 8-11 seconds, the actuator failed.

Personnel at the site observed actuator housing spring barrel failed catastrophically.

The spring had ejected

The valve stem and actuator stem separated at the coupling

The actuator had a operation range of 30 psig

The actuator had a maximum design pressure of 60 psig

The Instrument Air pressure was 115 psig.

OE17438 Brunswick 11/6/03

Mechanic were disconnecting actuator from the valve.

While disconnecting the coupling block, the spring tension forcibly ejected both halves of the coupling block.

The mechanic that was holding the coupling block dislocated his thumb. The coupling block also struck him in the face. Safety Glasses protected his eyes, but the glasses were driven into his eyebrow resulting in sutures being needed.

The spring tension should have been controlled or relieved.

Methods and Activities

OE13479 Braidwood 1/31/2002

Mechanics were performing disassembly of a valve actuator in the shop.

The actuator contained a top an bottom cap, three springs and a piston.

The mechanics slowly loosened the replacement rod nuts.

The cylinder came up off the bottom cap as expected when the springs would be detensioned.

The mechanics shook the parts to make sure the parts were loose.

There was no motion, therefore they conclude the springs were detensioned.

The mechanics removed the replacement rods.

The two mechanics stood on each side of the cylinder, making sure their faces were not above the cylinder.

The mechanics began to lift.

At this point, something released energy.

One mechanic was knocked over but was uninjured.

The other mechanic was struck in the face with the edge of the cylinder. He was taken to the hospital for treatment.

The most probable cause was that one of the inner springs had not completely expanded with the outer spring during disassembly.

Methods and Activities

Lab Activities

Reinforce PPE Requirements stated in Lesson Introduction

CAUTION : THE SBCV IS VERY LOUD WHEN OPERATING WITH AIR. HAVE ALL STUDENTS USE HEARING PROTECTION WHILE OPERATING THE VALVE.

Take the class to the SBCV Mock-up and demonstrate how to :

Satisfy the permissive - Use the 120vdc voltage source to energize the solenoid valve associated with the two small Ross valves.

Modulate the valve - After the permissive has been satisfied, use the transmation and vary the signal between 4-20mA to cycle the valve.

Quick open the valve - The permissive should be satisfied prior to performing a quick open, this is done to prevent the ross valve on the bottom associated with the permissive from trying to vent the quick open air to the bottom of the piston.

Energize the solenoid associated with the Large Ross valves, this will cause the valve to open very quickly.

Methods and Activities

Close Valve (remove permissive)

To close the valve, deenergize the quick open solenoid then deenergize the permissive solenoid.

SUMMARY OF MAIN PRINCIPLES

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

Objectives Review

Review the Lesson Objectives

Topic Review

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

Questions and Answers

Oral questioning

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

Problem Areas

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

Concluding Statement

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

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

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