



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
REGION IV  
611 RYAN PLAZA DRIVE, SUITE 400  
ARLINGTON, TEXAS 76011-8064

MAR 24 2000

Gregg R. Overbeck, Senior Vice  
President, Nuclear  
Arizona Public Service Company  
P.O. Box 52034  
Phoenix, Arizona 85072-2034

SUBJECT: MEETING TO DISCUSS CORROSION IMPACTS ON UNDERGROUND PIPING  
SYSTEMS (SPECIFIC EMPHASIS ON THE FIRE PROTECTION SYSTEM)

Dear Mr. Overbeck:

This refers to the meeting conducted in the Region IV office on March 21, 2000. This meeting was related to corrosion impacts on underground piping systems at the Palo Verde Nuclear Generating Station, Units 1, 2, and 3, facility.

During this meeting Mr. David Maudlin, Vice President - Engineering and Support, and other members of your staff, provided the ongoing efforts to identify, evaluate, and correct corrosion effects on the underground piping systems at Palo Verde Nuclear Generating Station. Additionally, your staff presented current Palo Verde Nuclear Generating Station initiatives regarding engineering calculations.

In accordance with Section 2.790 of the NRC's "Rules of Practice," Part 2, Title 10, Code of Federal Regulations, a copy of this letter will be placed in the NRC Public Document Room.

Should you have any questions concerning this inspection, we will be pleased to discuss them with you.

Sincerely,

Dr. Dale A. Powers, Acting Chief  
Engineering and Maintenance Branch  
Division of Reactor Safety

Docket Nos.: 50-528; 50-529; 50-530  
License Nos.: NPF-41; NPF-51; NPF-74

Enclosures:

1. Attendance List
2. Licensee Presentation

Template NRR-111

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-2-

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-3-

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-4-

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**ENCLOSURE 1**  
**ATTENDANCE LIST**



**ENCLOSURE 2**

**LICENSEE PRESENTATION**



# **Underground Piping Status and Station Update**



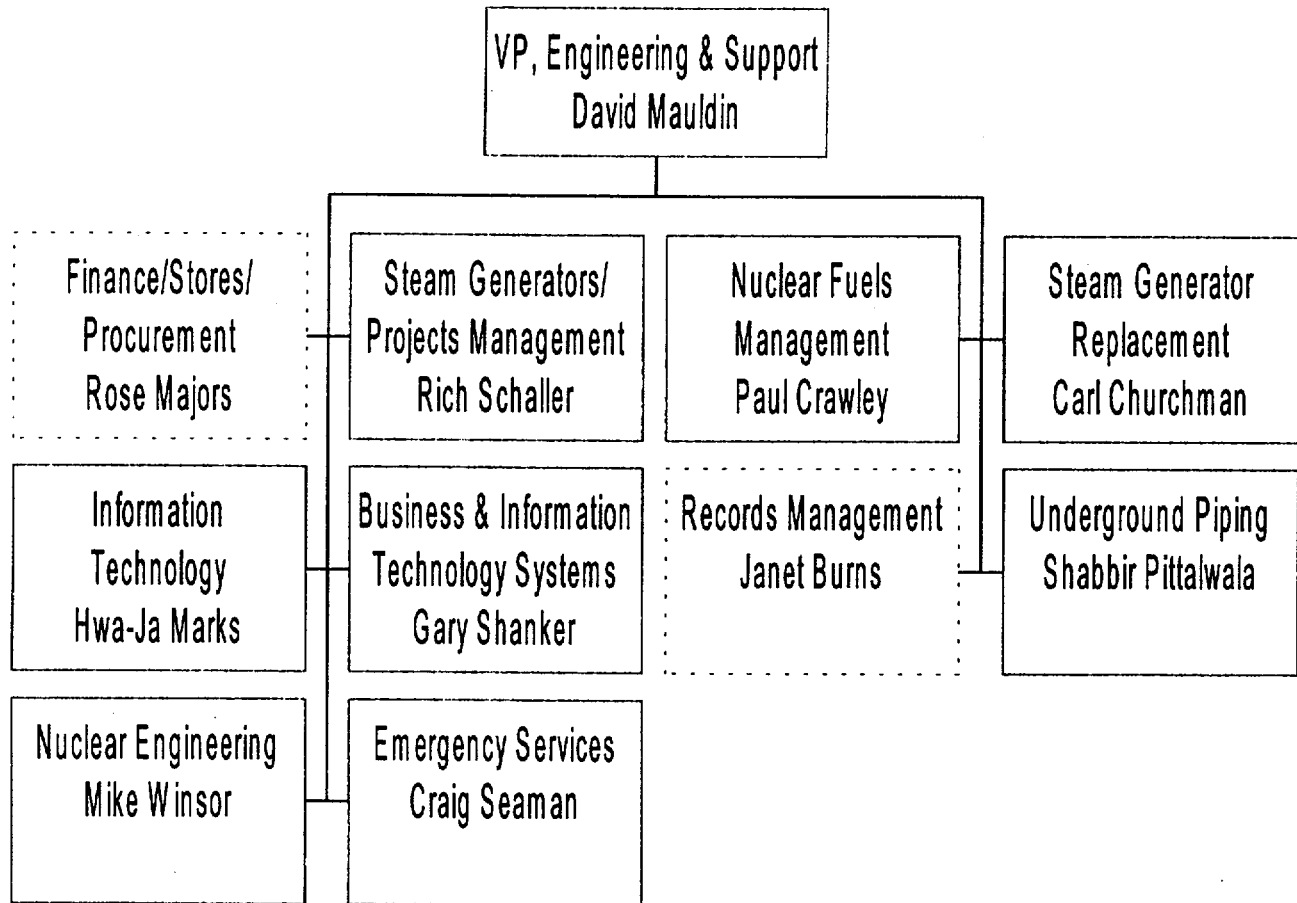
**March 21, 2000**

# Agenda

- **Introduction - David Mauldin**
- **Engineering Calculations - Mike Winsor**
- **Fire Protection - Frank Garrett**
- **Underground Piping - Shabbir Pittalwala**



# Palo Verde Engineering Organization



# **Palo Verde 2000 Strategic Focus**

- **Prevent Events/improve human performance**
- **Equipment Reliability - No failures in service**
- **Work management efficiency**
- **Thermal Performance enhancements**
- **Expand use of information technology**



# Engineering Calculations



**Mike Winsor**

## **Problem Statement**

- ◆ **NAD trending and NRC SSEI identified problems, such as:**
  - **Errors in calculations**
  - **Judgment not fully documented**
  - **Impacted calculations not revised**
  - **Identification of interrelationships lacking**
- ◆ **NAD Top 10**
- ◆ **Low safety significance**



## **Human Performance Evaluation Of Condition**

- ◆ **No common causal factor**
- ◆ **Error precursors present**
- ◆ **Process weaknesses identified**
- ◆ **Conclusion — human performance cause**



## **Actions**

- ◆ **Survey Region IV stations**
- ◆ **Train preparers, reviewers and leaders**
- ◆ **Enhance procedure**
- ◆ **Develop improved tool for impact reviews**
- ◆ **Develop monitoring/feedback tools**
- ◆ **Perform self-assessments**



## **Long Term Perspective**

- ◆ **Maintain the design and licensing basis**
- ◆ **Develop and implement programs that provide:**
  - **Barriers to avoid common problems**
  - **Proper balance between knowledge and formal procedures**
- ◆ **Create a Prevent Events culture within Engineering**



# **Palo Verde Fire Protection**



**Frank Garrett**



## **Fire Protection Defense-In-Depth Elements**

- ◆ **Design features such as non-combustible construction and circuit separation**
- ◆ **Fire prevention and administrative controls**
- ◆ **Fire detection**
- ◆ **Manual fire suppression**
- ◆ **Automatic fire suppression**
- ◆ **Passive fire barriers**



## **Fire Protection Water Supply Basic Requirements**

- ◆ **Able to supply anticipated fire water requirements in accordance with design and licensing basis**
- ◆ **Indicating valves provided for isolation during maintenance/repair without shutting off entire system**
- ◆ **Independent fire water supplies**



## **Palo Verde Configuration**

- ◆ **Two independent 500,000 gallon supplies**
- ◆ **Three backup water supply locations (cooling tower basins)**
- ◆ **Three 50 percent capacity fire pumps capable of 4,500 gpm combined capacity (rated)**
- ◆ **Extensive fire main system with sectional isolation capability**
- ◆ **Redundant feeds to safety-related areas**



## **Fire Protection Piping System Improvements**

- ◆ **Cathodic protection system — 1987/1999**
- ◆ **Relined fire water tanks — 1995**
- ◆ **Fire water tank anode replacement — 1990/95**
- ◆ **Fire water tank/domestic water separation — 1995**



## **Fire Protection Piping System Improvements**

- ◆ **Deep well pump casings repaired — 1993/94**
- ◆ **Chemical Addition System — 1995**
- ◆ **Installation of air dryers for pre-action pipe systems — 1997**
- ◆ **Corrosion rate monitoring — 1989/2000**

more ...



## **Fire Protection Piping System Improvements**

- ◆ **Post indicator valve replacement — 1999**
- ◆ **Underground pipe wall thickness mapping — 2000**
- ◆ **Operations controls**
  - **System flushing**
  - **Pre-action system drop-leg draining -**
  - **Loop flow testing**

more...



## **Fire Protection Piping System Improvements**

- ◆ **System team ownership**
- ◆ **Senior management oversight**
  - **Level 1**
  - **OSRC**

more...



## **Fire Protection Piping System Status**

- ◆ **Corrosion rates trending below 1.0 MILS/year**
- ◆ **Water chemistry within desired range**
- ◆ **Fire pump availability exceeding goal of 90 percent**
- ◆ **Fire pump hydraulic performance acceptable**

more...



## **Current System Status**

- ◆ **Underground loop hydraulic performance acceptable**
  - Last test 4,654.8 gpm at 104 psi
  - Requirement 4,000 gpm at 80 psi
- ◆ **Ability to isolate system**
- ◆ **System leaks infrequent for piping supplying safety-related areas**



## **Fire Safety Significance**

- ◆ **Water supply capability far exceeds nuclear safety needs**
- ◆ **Limited reliance on fire-water suppression systems for Appendix R compliance**
- ◆ **System performance closely monitored**



# 2000 Underground Piping Project



**Shabbir Pittalwala**

## Purpose

- ◆ **Ensure long-term health and reliability of piping systems**
- ◆ **Pipe failures (WRSS) and leaks (FP, CM, DS) - since 1996**
- ◆ **Inspection/repairs - 1997**
- ◆ **Refine inspection/repair techniques - 1998**
- ◆ **Form Underground Piping Group - 1999**
- ◆ **Focused enhancement efforts - 2000**

*Note: Operational impacts mitigated by redundant/loop design and aggressive remedial actions.*



## Description Of Problem

- ◆ **Operating experience**
  - . **External corrosion:**  
corrosive soils-chlorides and sulfates
  - . **Internal corrosion:**  
acids, chlorides in process fluids and  
Microbial Influenced Corrosion (MIC)
- ◆ **Site priorities to address experiences**



## Pipe Categories

### ◆ Concrete pipe systems

- CW, TBMU, TBBD, PW

### ◆ Metallic pipe systems

- ■, CC, CD, CH, CI, CM, ■, ■, DS, DW, FP, GA, IA, LO, NC, OS, OW, RP, RS, SC, ■, SPD, ST, TC

■ These are safety-related systems.



## Priority Ranking System

- ◆ Safety related significance/risk significance (PRA review)
- ◆ Pipe operational experience inspections, failure history, industry operating experience, lessons learned
- ◆ Impact to environmental requirements-consequence of failure
- ◆ Impact to plant operations-plant/unit/system outages or compensatory actions





## Ranking Results

### ◆ Concrete pipe

#### Priority A

TBMU-  
redundant

TBBD

CW-inspected,  
repairs  
ongoing

#### Priority B

PW-Inspection  
ongoing: Unit 1  
good



## Ranking Results

### ◆ Metallic pipe

#### Priority A

CM

FP

SP

#### Priority B

CD

CH

DF

DW

OW

NC

SC

TC

#### Priority C

CC

CT

DS

GA

IA

LO

OS

SPD

ST



## **System Status**

- ◆ **Chlorine Injection/Chemical Waste - degraded piping replaced**
- ◆ **Fire Protection - separated from Domestic Water, chemical/biocide treatment, cathodic protection upgraded, valve replacement/inspections ongoing**

more...



## **System Status**

- ◆ **Essential Spray Pond - visual examination, chemical treatment, harvested spool examined (pit depth .035" in .365" pipe metal)**
- ◆ **Enhanced inspection/repair techniques**



## **Actions Taken**

- ◆ **Cataloged, categorized and prioritized all underground piping**
- ◆ **Developed inspection plans**
- ◆ **Commenced replacement/repair**
- ◆ **Enhanced inspection/repair techniques**



## **Ongoing Actions**

- ◆ **Baseline inspection and condition evaluation-FP, SP, PW, CW, OW**
- ◆ **Repair/replacement of degraded piping-CI, CM, FP, TB, CW, WRSS**



## Conclusions

- ◆ Piping was designed with accepted protection: redundant trains/loop design, corrosion resistant coatings and linings, non-corrosive materials, cathodic protection, chemistry controls
- ◆ Pipe corrosion has occurred due to internal/external corrosive attack
- ◆ Focused attention and deliberate actions are ongoing to ensure reliability



## System Names

<u>Acronym</u>	<u>Name</u>
AF	Auxiliary Feedwater
CC	Chemical Production
CD	Condensate
CH	Chemical and Volume Control
CI	Chlorine Injection
CM	Chemical Waste
CT	Condensate Transfer and Storage
CW	Circulating Water



## System Names

<u>Acronym</u>	<u>Name</u>
DF	Diesel Fuel Storage and Transfer
DS	Domestic Water
DW	Demineralized Water
FP	Fire Protection
GA	Service Gases
IA	Instrument and Service Air
LO	Lube Oil
NC	Nuclear Cooling



## System Names

<u>Acronym</u>	<u>Name</u>
OS	Lube Oil Storage, Transfer and Purification
OW	Oily Waste
PW	Plant Cooling Water
RP	Raw Water
RS	Raw Water Supply
SC	Secondary Chemical Control
SP	Essential Spray Pond
SPD	Settling Pond Drain



# System Names

<u>Acronym</u>	<u>Name</u>
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ST	Sanitary Drainage
TBBD	Cooling Tower Blowdown
TBMU	Cooling Tower Make Up
TC	Turbine Cooling
WRSS	Water Reclamation Supply System

