329

PAPER 12

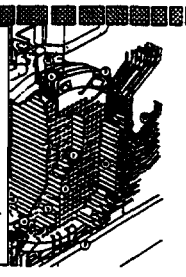
P. THOMPSON, SUPERINTENDENT
PT. LEPREAU NGS
NEW BRUNSWICK POWER

M.A. PETRILLI, SAFETY ANALYSIS MANAGER
GENTILLY 2
HYDRO QUEBEC

CANADA

Managing Safety at CANDU Plants

Safety Aspects of Plant Ageing



P.D. Thompson
M.A. Petrilli

Contents

- Overview
- Attributes of a good ageing program
- Safety Aspects of plant ageing
- example of PT diametral creep
- Discussion

Overview

- There are many aspects to plant ageing
- Some aspects were accounted for in the design
- Remainder "Learn as we go"

Overview (Cont'd)

- Ageing is of interest to both utilities & designer due to potential economic & Safety impact
- economic costs are related to greater equipment refurbishment or replacement and replacement power

Overview (Cont'd)

- Clearly an overall ageing & maintenance plan covering all aspects of the plant would be beneficial
- This talk concentrates on the Safety aspects of plant ageing but recognizes the close linkage of safety to economics

Attributes of a good Ageing Program

- An overall plan for each system identifying:
  - the degradation mechanisms
  - how to look for them
  - how often to check
  - what are the limits & margins to limits
  - what are the remedial actions
  - safety & cost implications

Attributes of a good Ageing Program (Cont'd)

- Plan should be based on a systematic review, be documented, and supported by an ongoing data base

Attributes of a good Ageing Program (Cont'd)

Ageing Attitude

- In addition to the plan, the Program must recognize:
  - importance of staying within spec
  - following up on unusual failures / observations
  - trade off between proactive prevention versus downtime

Benefits of a good Ageing Program

- Simplified, it is like a car maintenance guide
- Used by vendors to support sales
- Provides utilities with economic piece of mind, as well as continued assurance of plant safety
- maximizes economic plant life

Status

- We have many bits & pieces but no overall CANDU plan
- much work still remains in the area of performing a systematic review
- In the mean time we must continue to
  - infer / assess / monitor
  - compensate & correct
  - share information & experiences

Safety Aspects of Plant Ageing

- If unchecked, ageing has the potential to adversely affect safety due to:
  - changes in conditions & equipment
  - "institutional degradation"

Safety Aspects of Plant Ageing

Changes in equipment &Condition

- Increased probability of component failures leading to event initiation
- Increased severity of consequences of an accident due to:
  - reduced availability of SSS
  - reduced effectiveness of SSS
    - changes in process conditions
    - changes in accident progression

Safety Aspects of Plant Ageing
Institutional Degradation

- Staff (knowledge & skills)
- Documentation
- Configuration Management

Safety Aspects of Plant Ageing
Increased Probability of failures leading to accident

- Formation of hydride blisters on PT leading to PTR (Pickering G-16)
  - hydrogen pickup during NOC
  - PT sag leading to PT/CT contact
- FAC leading to leaks then to breaks
  - SS piping
  - outlet feeders

Safety Aspects of Plant Ageing
Increased severity of consequence of accident

- Reduced SSS Availability
  - failures typically included in reliability studies
  - those not "failures undetected by system testing"
    - MOV torque switch settings
    - instrument calibration
    - neutronic instrument dynamics
    - RB leakage

Safety Aspects of Plant Ageing
Increased severity of consequence of accident

- Reduced SSS effectiveness
  - changes in process conditions (trip margins)
  - changes in accident progression
    - PT blisters (G-16)
    - boiler tube leaks
    - EQ (cables)
    - material properties (ability to withstand failures)
    - PT diametral creep

PT Diametral Creep

- Creates a large subchannel over the bundle (path of lower resistance) leading to:
  - flow redistribution in the core
  - bundle bypass
- CCP effect initially positive and then goes strongly negative

PT Diametral Creep (Cont'd)

- PT creep must be considered in concert with the other PHTS ageing mechanisms and effects:
  - boiler fouling
  - increased resistance in boiler & inlet feeder
  - PHTS asymmetries
- Effects ROP & BP/CP limits

PT Diametral Creep (Cont'd)

- NBP/HQ/AECL have spent considerable effort to monitor, model and assess the effects
  - boiler pressure reduction
  - boiler divider plate changeout
  - boiler cleaning
  - USFM (cold & on line)
  - Trih calibration

PT Diametral Creep (Cont'd)

- PLGS has incorporated effect into ROP setpoint on an interim basis
- PLGS & G-2 performing detailed assessment for ROP
- TC studies are being scoped
- Both stations are considering the use of CANFLEX fuel to restore margins

Future Analytical Programs

- Effect of FC sag on
  - Reactor control
  - BP/CP uncertainties & limits
  - SDS effectiveness for LOCA & incore breaks