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Overview of CHECWORKS

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Background

- Surry Unit 2 accident – December 1986
  - Demonstrated need to inspect single-phase piping
  - Limited US inspection programs were in place for single-phase FAC
- In 1987, EPRI & NUMARC committed to develop a computer program (CHEC) to assist in selecting inspection locations in BWRs and PWRs
  - NUMARC issued programmatic guidance including use of CHEC or equivalent method.
- CHEC later revised and enhanced as CHECWORKS

CHEC Development Approach

- The EPRI CHEC development team gathered data from Europe:
  - Laboratory data from CEGB (England)
  - Laboratory data from EDF (France)
  - Plant and laboratory data from Siemens (Germany)
- All known laboratory data were obtained
- Used limited US plant data
- Used existing scientific knowledge to structure correlation between piping wear and plant operating parameters
- EPRI released CHEC 7 months after Surry accident

Mathematical Analogue

- Extending the Keller and the Kastner correlations & the Berge model, Chexal and Horowitz designed and implemented a new algorithm to be used in the CHEC program.
- $\text{FAC Rate} = F_1 * F_2 * F_3 * F_4 * F_5 * F_6 * F_7$
- Where:
  - F_1 = Temperature factor
  - F_2 = Mass transfer factor
  - F_3 = Geometry factor
  - F_4 = pH factor
  - F_5 = Oxygen factor
  - F_6 = Alloy factor
  - F_7 = Void fraction factor (CHECMATE & CHECWORKS)

Improvements Over Previous Approaches

- CHECWORKS:
  - Uses a larger database of experimental and plant data.
  - Incorporates <u>local</u> conditions through water chemistry modeling (pH and dissolved oxygen), void fraction and flow modeling (velocity, pressure and enthalpy).
  - Uses geometry factors from plant data with insight from copper modeling tests.
- CHECWORKS' algorithm has been continually validated and refined, as necessary, against new plant and laboratory data.

CHECWORKS Input Parameters

- **Heat Balance Diagram** – one time input
- **Global plant conditions** – power level, thermodynamic conditions, water chemistry and operating time for each operating period
- **Plant component conditions** – component geometry, material, size, wall thickness, operating and design conditions, flow rate and quality (if not available from flow analysis)
- **Component replacement information** (if applicable)
- **Inspection data** (if applicable)

Plant Modeling

- The plant is divided into a number of lines having roughly the same water chemistry and operating conditions—*e.g.*, feedwater between feedwater heaters.
- Depending on the complexity and amount of resistant material in the plant, there are normally 25 to 50 of these "analysis lines."
- Using the global information, the wear is calculated for each operating period, and the lifetime wear of each component is calculated by summing up the calculated amounts of wear for each period.
- Not all of the lines in a plant are suitable for analysis using CHECWORKS.

How CHECWORKS Works

- CHECWORKS is designed to handle:
  - Changes in operating conditions (e.g., flow rate)
  - Changes in water chemistry (e.g., oxygen concentration)
- The two basic design considerations are to:
  - Model changes in conditions, including the ability to forecast the impacts of such changes.
  - Integrates the treatment of inspected and non-inspected components.
- CHECWORKS is one tool to ***help select*** inspection locations.

How CHECWORKS Works (cont.)

- Pass 1 is an analysis done without considering inspection data.
  - A Pass 1 analysis is typically used to select initial inspection locations.
- The user has the option to include inspection data – this is known as Pass 2.
  - For Pass 2, the user can compare how well the program's predictions match the measurements.
  - Pass 2 predictions go through the center of the data (*i.e.*, program is 'best estimate').

Analyzing Predicted and Observed Data

- Part of the Pass 2 feedback is the program-computed line correction factor (LCF).
- The LCF is computed separately for each Pass 2 line.
- The user also can view predictions versus measurements on various plots and tables allowing the identification and examination of any outliers.
- The user then decides whether lines are 'calibrated' or 'not-calibrated' using guidance found in NSAC-202L R3, considering the LCF and other factors.

Program Outputs

- For each component, in each line analyzed, CHECWORKS provides:
  - Predicted wear rate
  - Predicted thickness
  - Predicted time to reach critical thickness
- For Pass 2 analysis, CHECWORKS provides the LCF and measured thicknesses

Program support

- EPRI conducts periodic training in FAC issues and the use of CHECWORKS.
- EPRI maintains hotline support through a phone line and website.
- EPRI sponsors a FAC interest group – CHUG – which holds two meetings a year.
- CHECWORKS is periodically updated to meet user feedback.

Thank you for your attention.

- Questions?

End of presentation