Source Term Reduction Efforts at Ringhals PWR´s - Challenges and Successes

North American 2013 ISOE ALARA Symposium
Ft.Lauderdale

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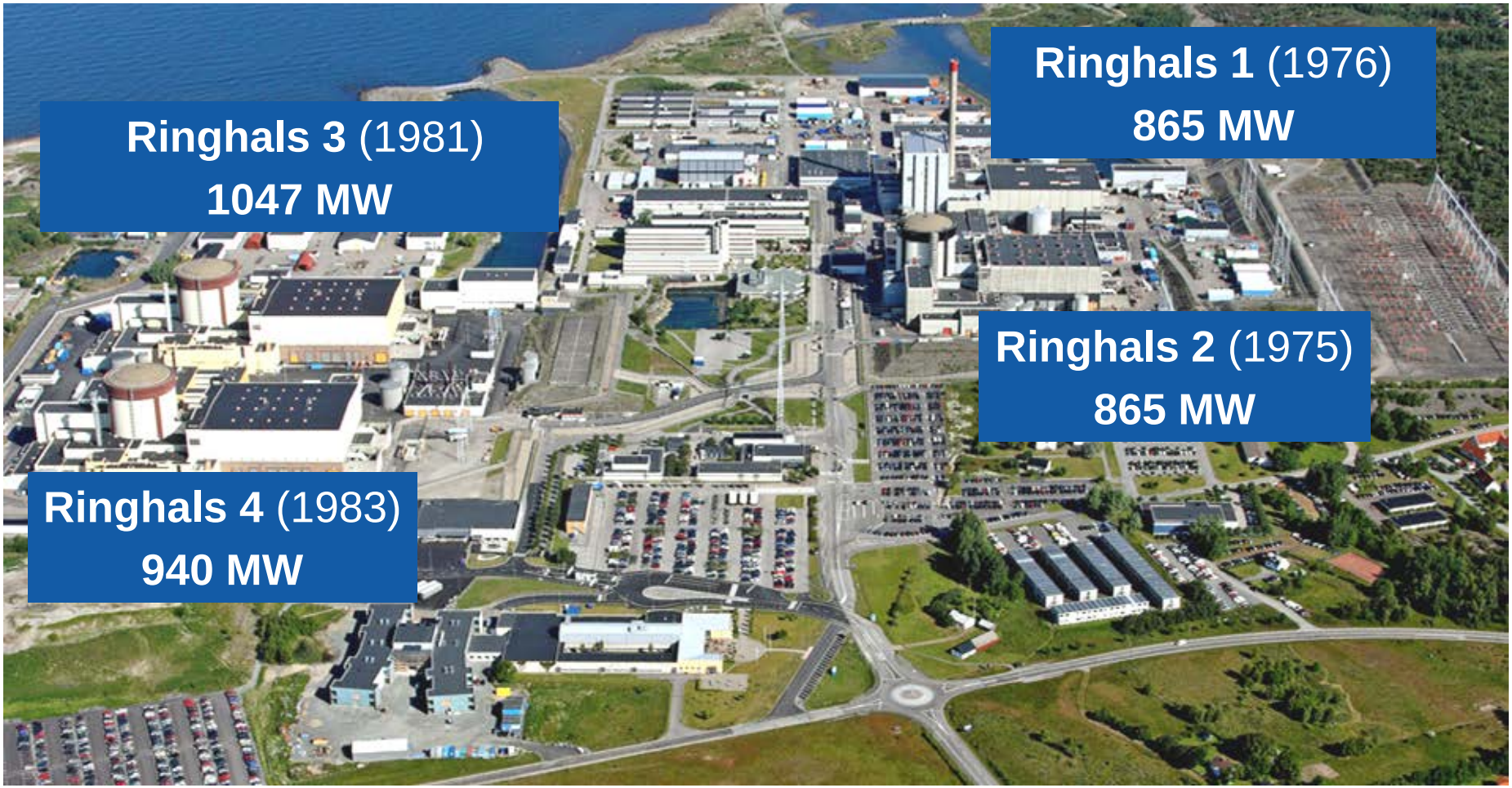
Ringhals – the largest power plant in Sweden



Objectives

- **Ringhals PWR Source Term Reduction Work Group**

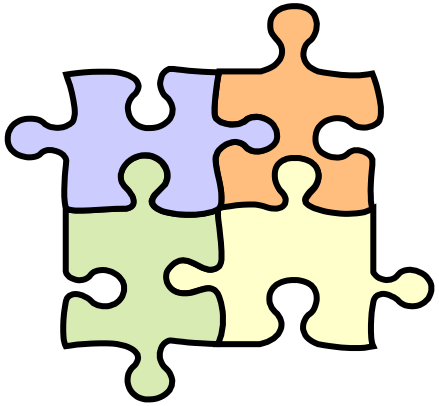
  - **Challanges**
  - **Data collection**
  - **Status**
  - **Sucesses**
  - **Future challanges**

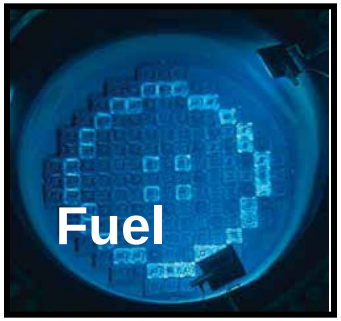
Start up Source Term Reduction Work Group in 2009

Why?

- **Upcoming SG + PRZ replacement (2011) with power uprate with 18% close to SGR**
- **Ag-110m, Sb-124 issues**
- **Poor Shut Down Release Control**
- **Elevated dose rates in cold and low flow areas**

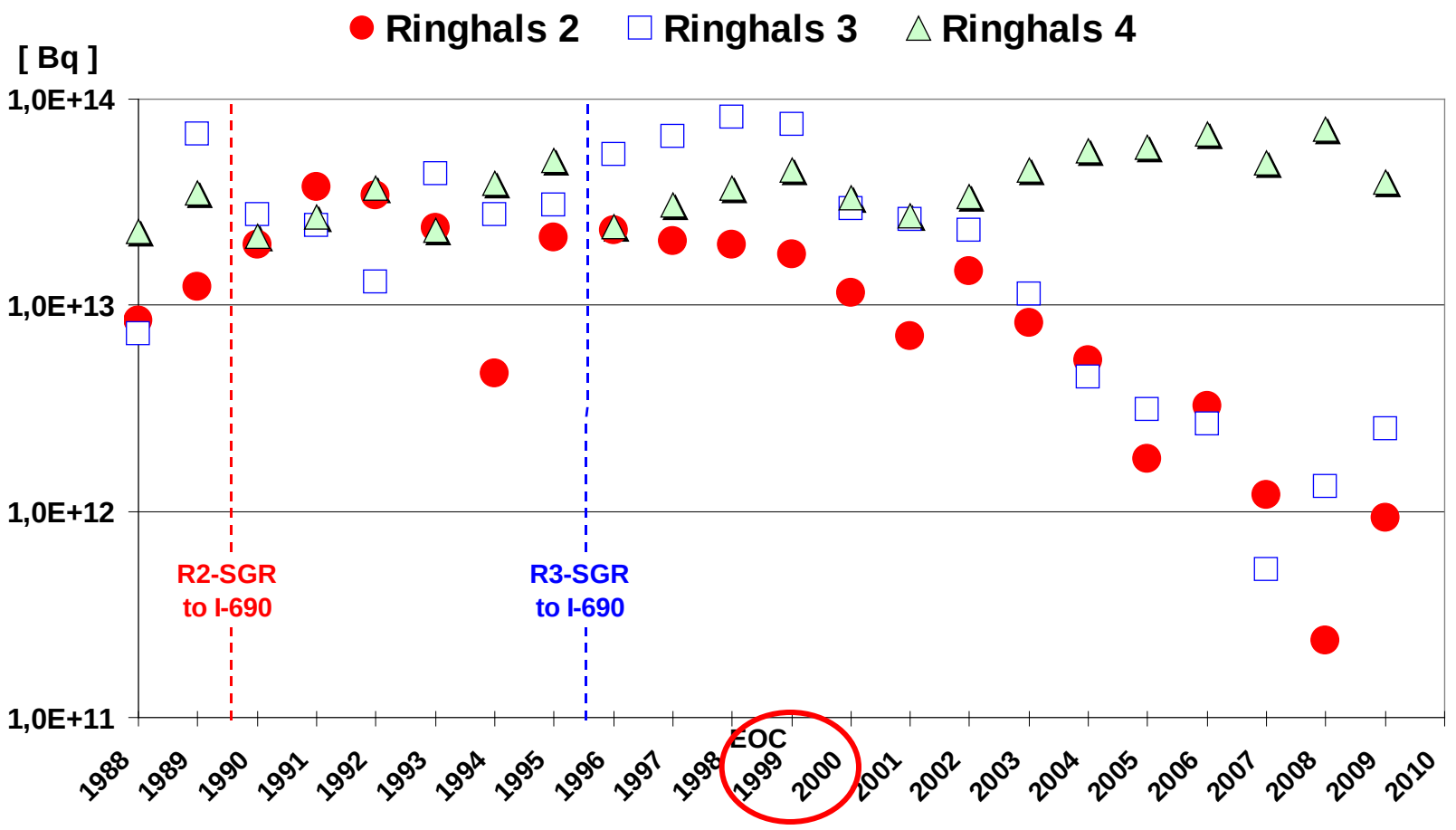
Source Term Reduction Work Group





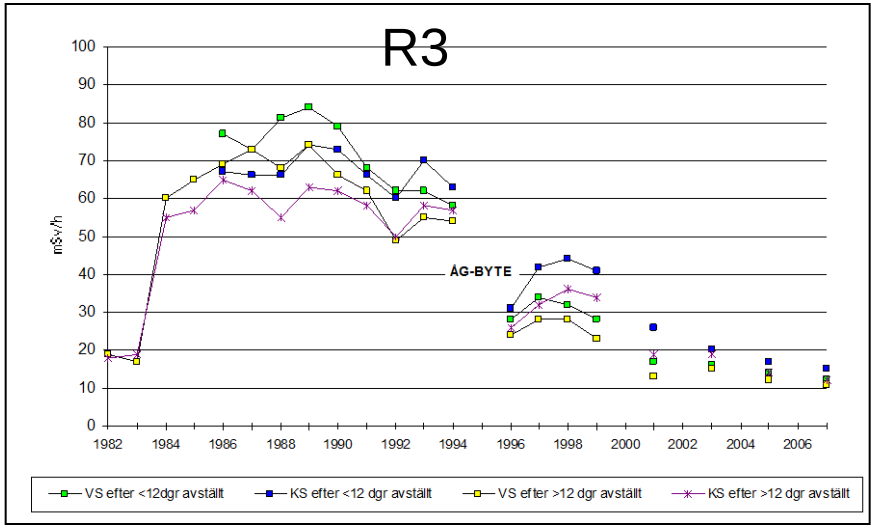
- **R4 source terms, fuel crud deposits and radiation fields grows and is estimated to be higher then unit 2(1989) and 3(1995)**
- **Possible power uprate with 18% close to SGR will give significant increase of SNB**
- **Cycle 1-3 after SGR may further increase the source terms of Ni and 58Co due to initial corrosion and conditioning of 20 000 m2 (+40%) new SG tube surfaces**
- **All together, high SNB with elevated Ni may give fuel crud deposits with high risk of CIPS/AOA**

Shut down Release (fuel crud burst) Co-58

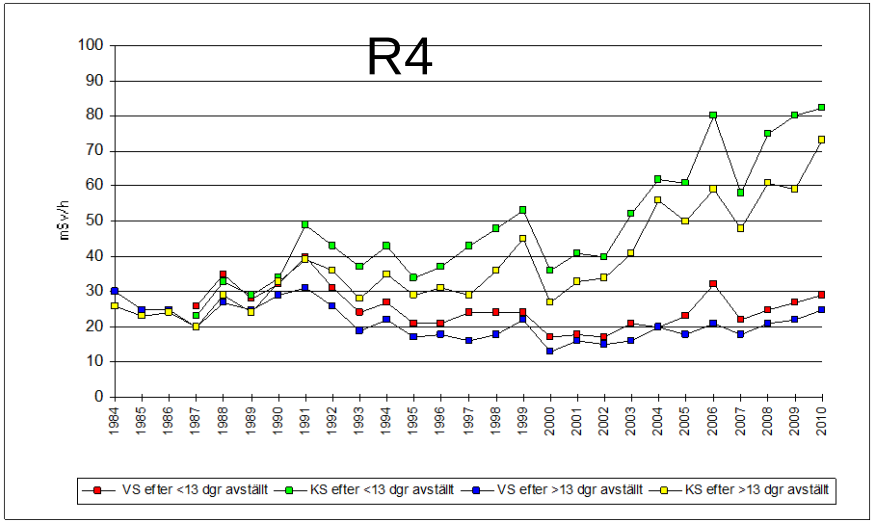


Implementation of elevated pH

SGCH Doserate trends



- elevated pH implemented in year 1999 at R2 and in year 2000 at R3



- elevated pH has not been possible to implement on unit 4 due to old SG tubing

Recomendations for unit 4 (given 2010)

- **Lower the Co-58 activity limit set point after crud burst from 6 E6 Bq/kg to 5 E5 Bg/kg** *(EPRI guideline = 1,6 E6)*

  (cleanuptime with RCP running from 12 hours to 36 hours)

- **Implementation of elevated pH program at BOC after SGR**

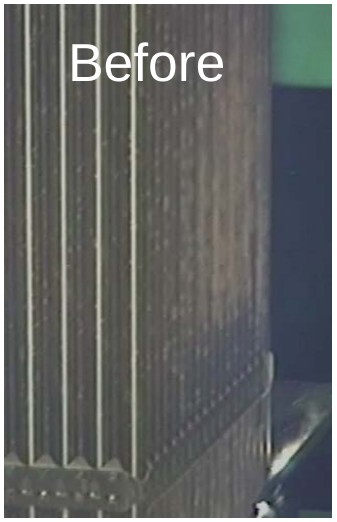
- **Optimized shutdown chemistry control**

- **Implementation of Zink injection**

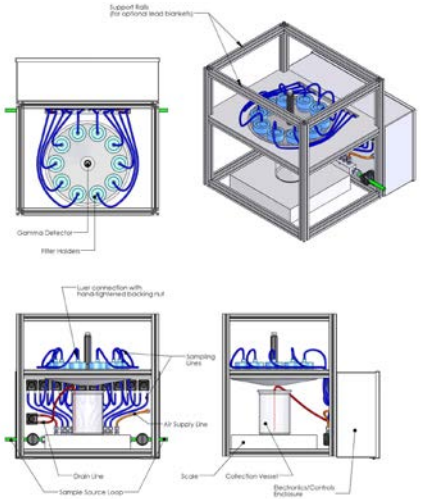
- **Ultrasonic Fuel Cleaning (UFC) of reloads cycle 0-2 after SGR**

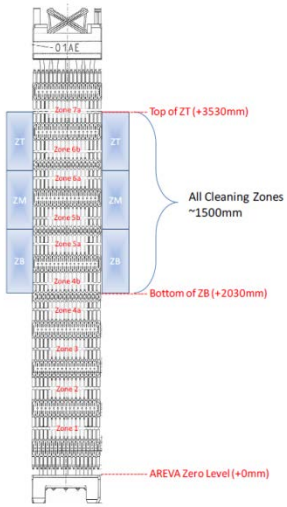
- **Mid Cycle Shut Down (cold) after 1-2 months of operation for the clean up of corrosion products (mainly nickel) on fuel and primary surfaces by a ordinary peroxide treatment**

Ultra Sonic Fuel Cleaning



- 119 fuel elements decontaminated (3,4 elements /hour) performed by Dominion
- visually about 90% of the crud was removed
- Ringhals owns the equipment





- 76 CRUD samples were taken
- Gamma measurements on samples shows that 90% of the crud was removed
- Final result will be presented in an EPRI report

Data collection

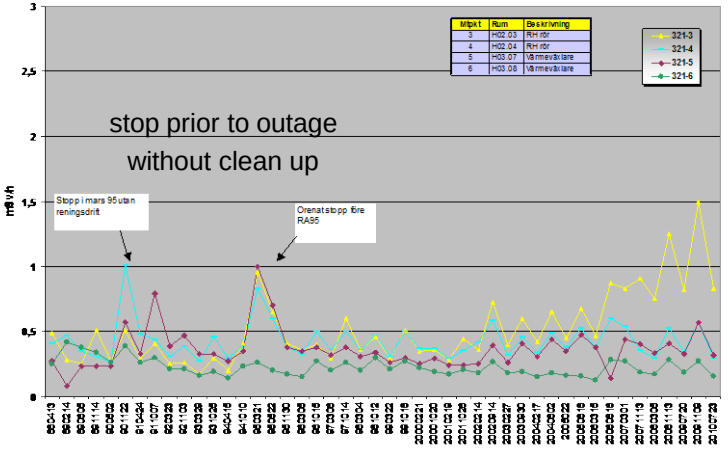
ID	Type of data collected	Method	Number of measuring points	Times/ Cycle	Times/ Shut down
1	EPRI - SGCH	TLD	18 (3 x 6)		1/3
2	EPRI - RCSLP	TLD	27 (3 x 9)		3
3	Plant Specific Repetitive Measurments	Automess + shielded probe	35	2	1
4	SAM – surface activity measurment	Collimated Ge-detector	Unit 2 - 8 Unit 3 - 7 Unit 4 - 7	2 2 3	1 1 1
5	RHR piping during clean up	Automess + shielded probe	20		3

= input to dose rate indicator (DI)

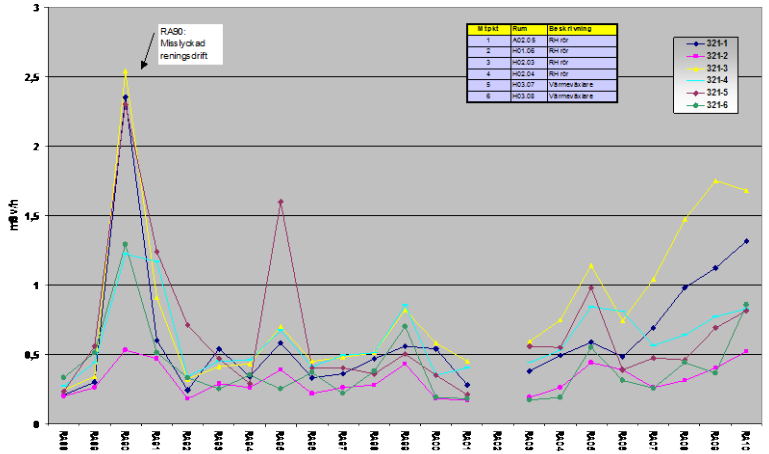
Locations for plant specific repetitive measuring points

- RCS
  - *Surge line, PRZ, sprayline piping*
- RHR
  - *piping, HX Shell*
- SI
  - *piping*
- SF
  - *piping inlet and outlet HX*
- CVCS
  - *Let Down piping, HX shell, charging pumps, regenerative HX*

R3 RHR during operation

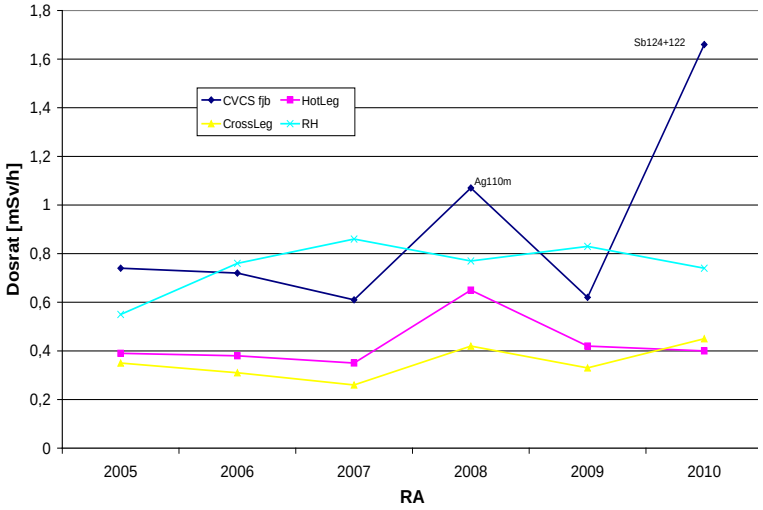


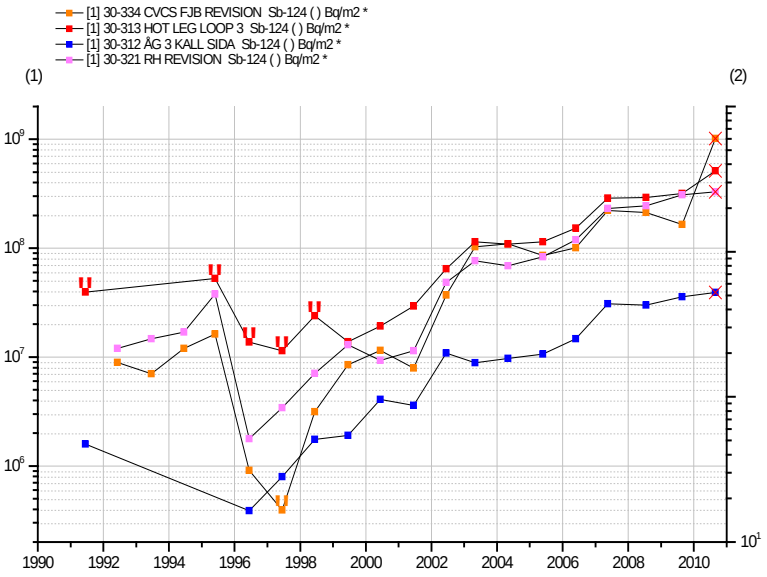
R3 RHR during shutdown



Shut Down (clean up) follow up

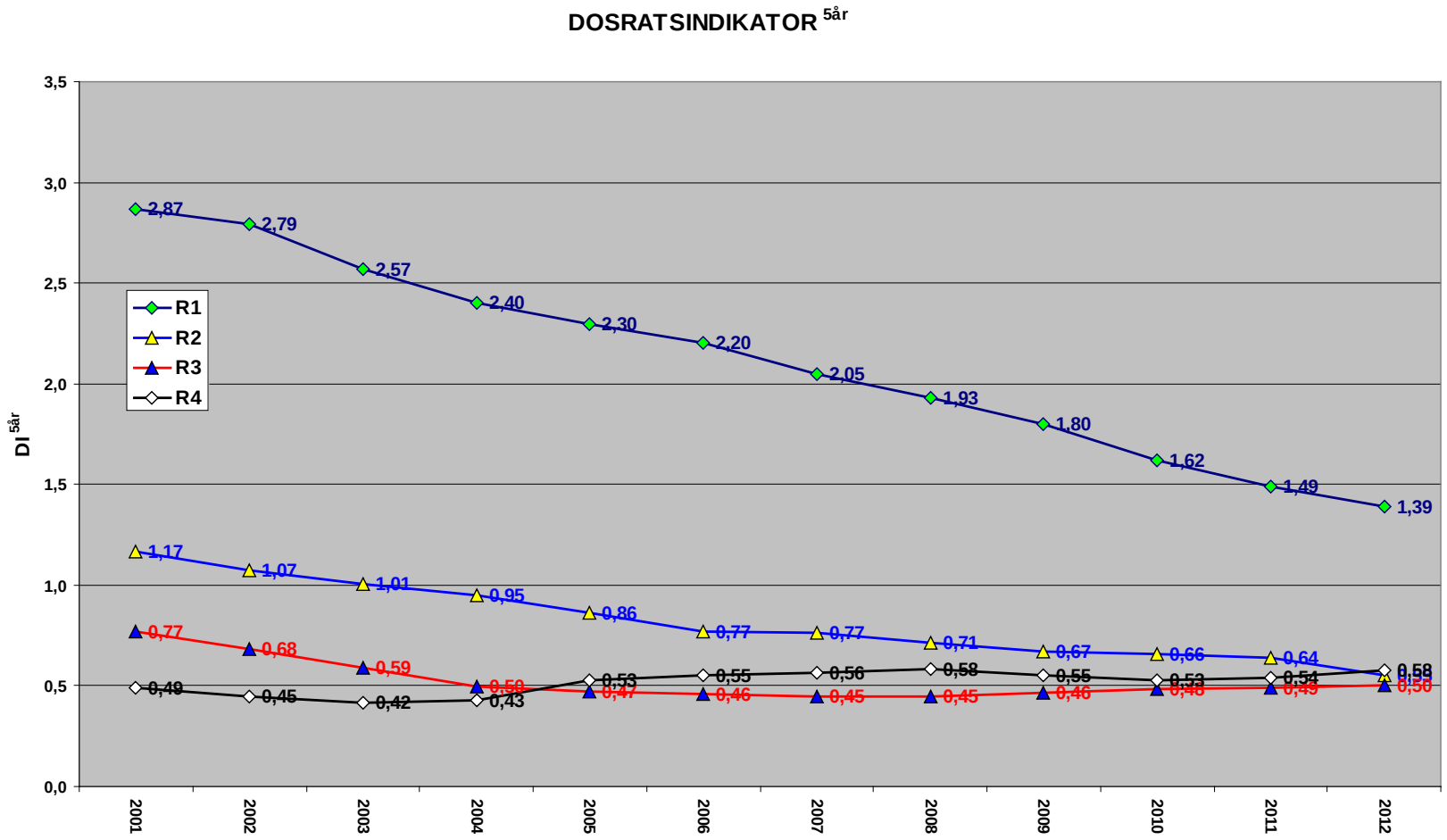
- On line dose rate measurement on RHR piping
  - *Set up prior to outage*
- Repetitive measuring points
  - *Prior to oxidation (before RHR starts running)*
  - *mid time start injection/stop of RCP (normally 6 hours)*
  - *1 hour after stop of last RCP*
- SAM – gamma spectroscopy
  - *RHR and CVCS let down piping*



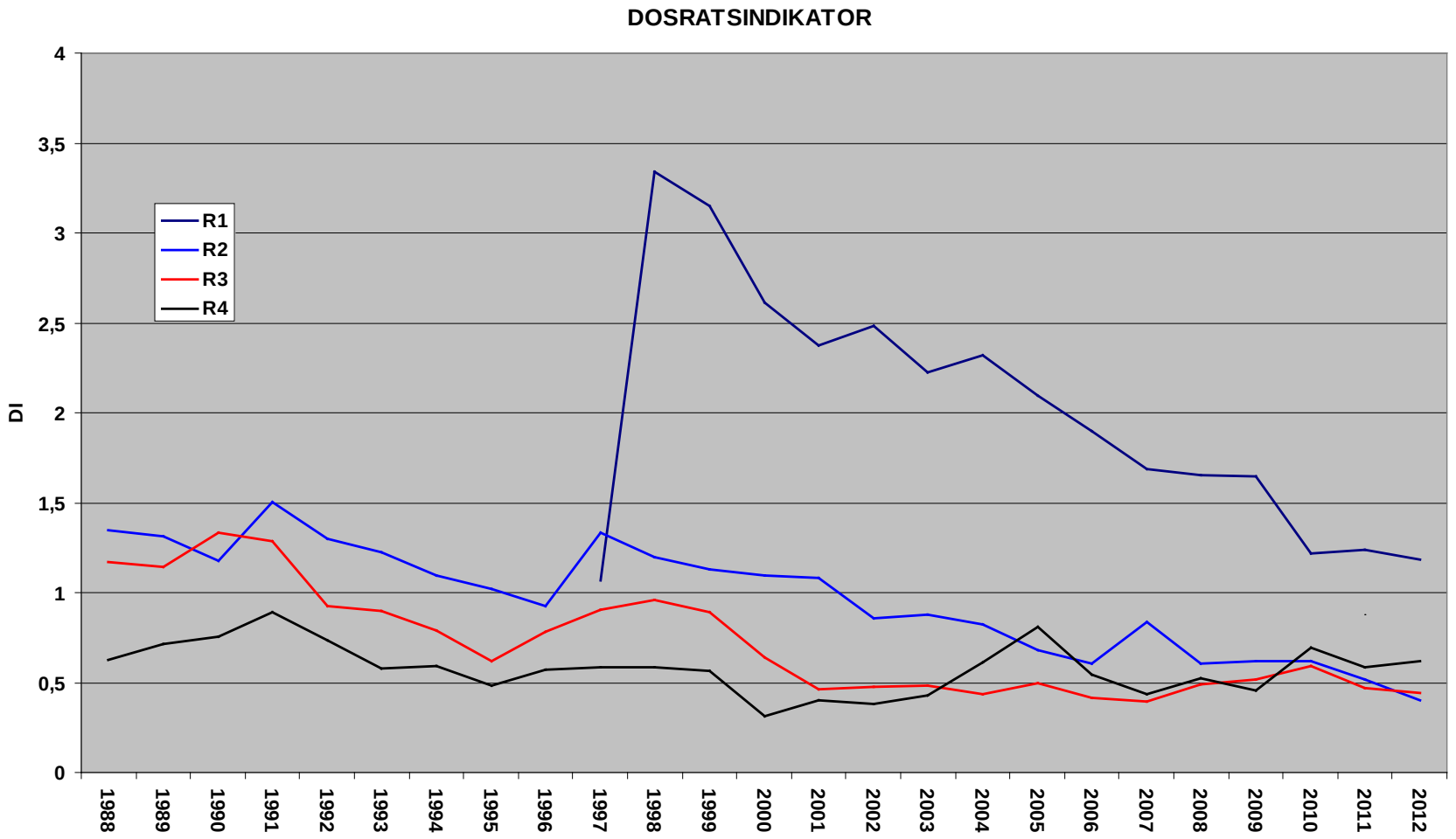


Status and future challenges

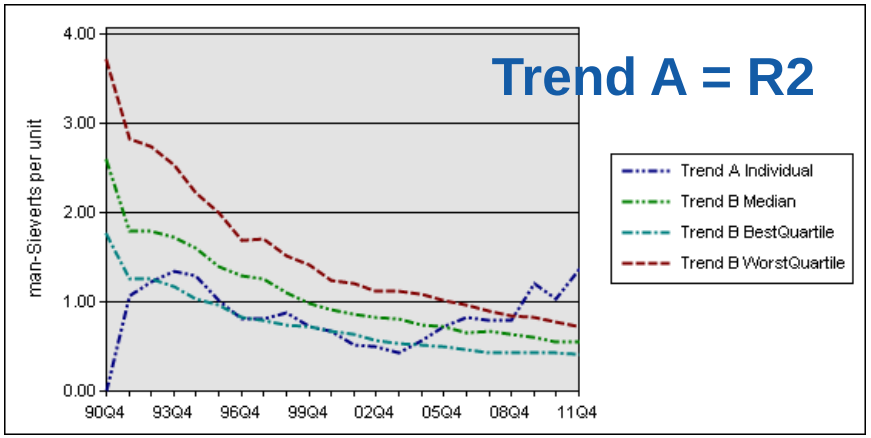
Doserate indicator – 5 years rolling

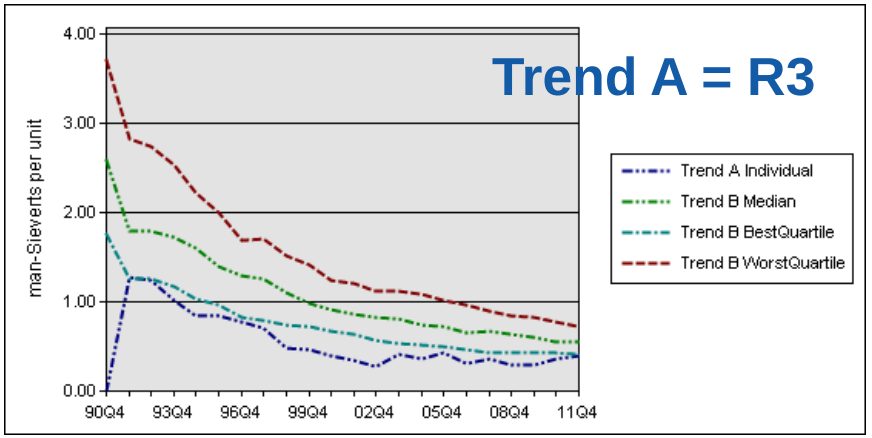


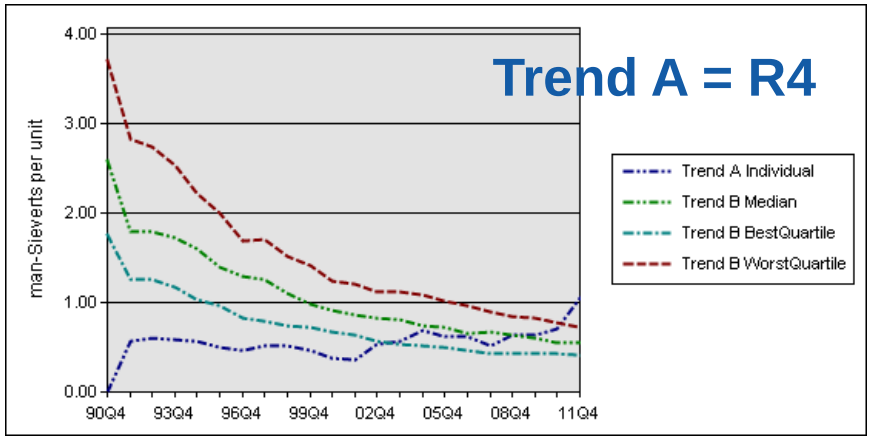
Doserate indicator



Ringhals unit 2-4 – PWR ”Worldwide” WANO CRE







Goal is to reach best quartile in 2015! (?)

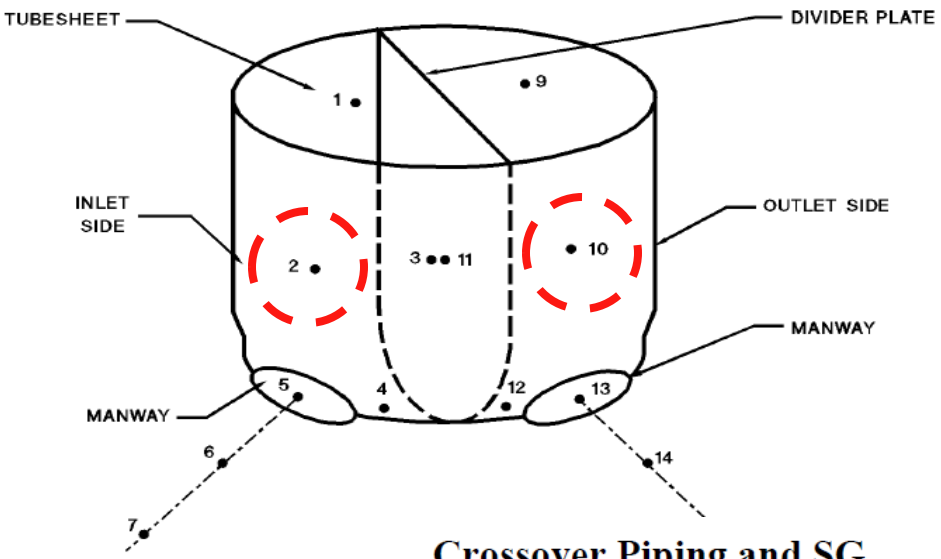
Benchmarking EPRI - SRMP

SRMP

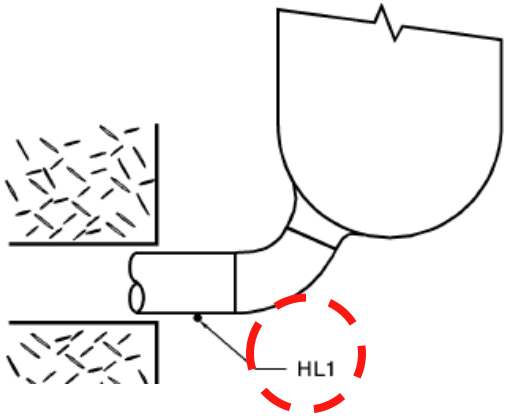
Standard Radiation Monitoring Program

comparable measuringppoints/result

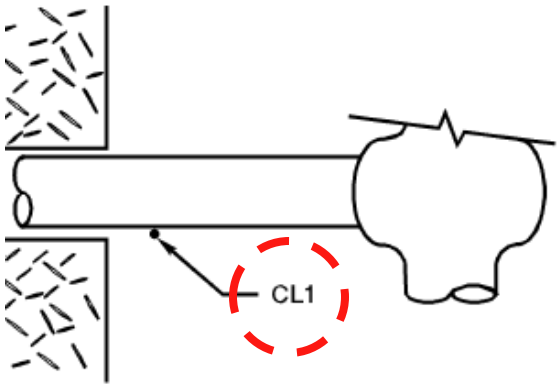
Steam Generator Channel Head (Manway Cover Removed)



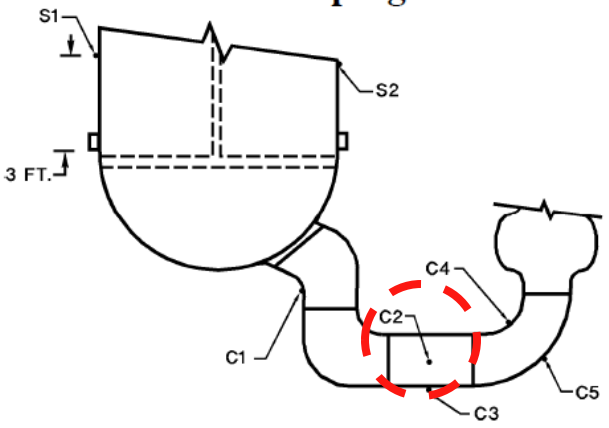
Hot Leg Piping



Cold Leg

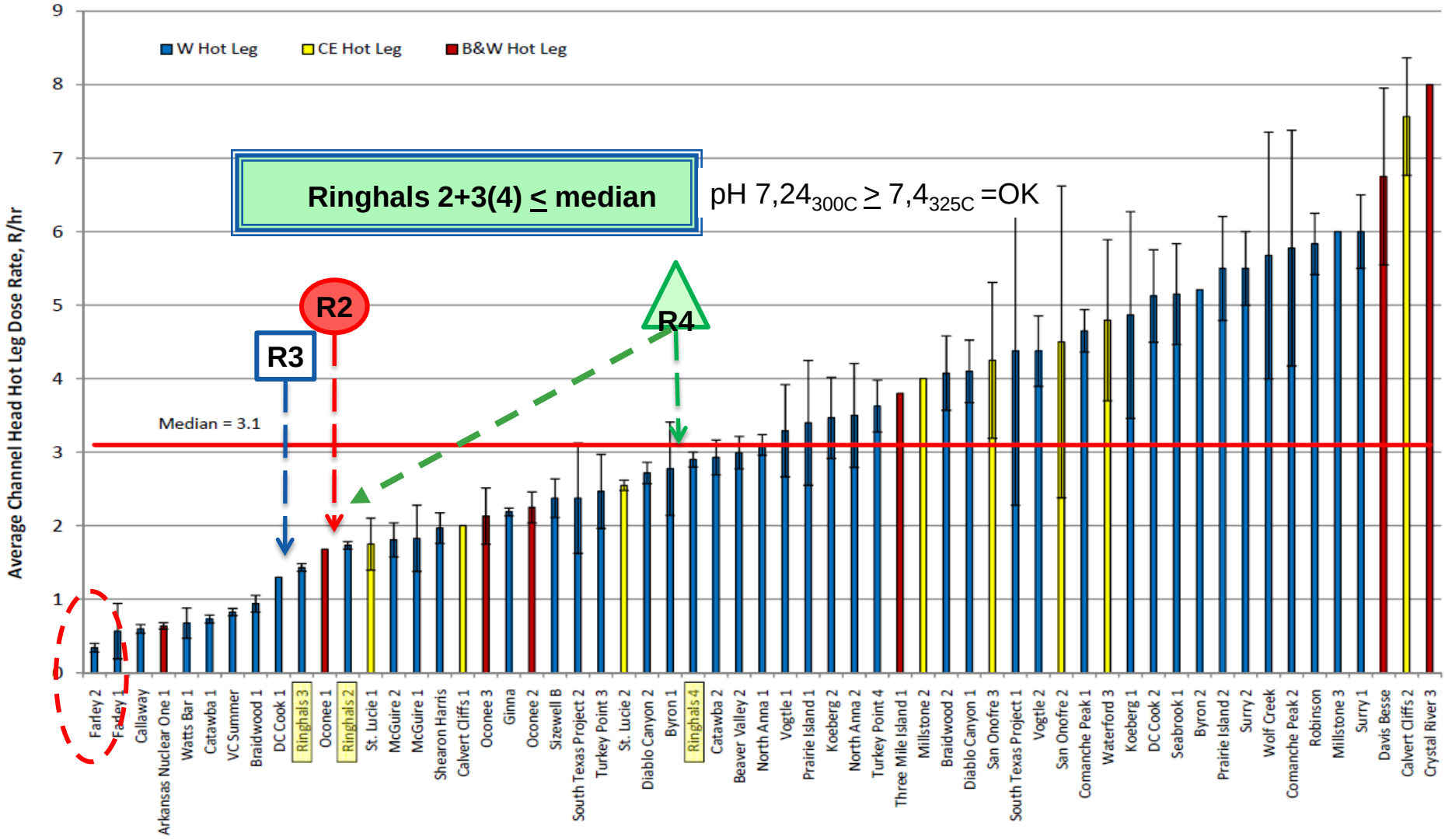


Crossover Piping and SG



VATTENFALL

EPRI-SRMP: SGCH – Hot Leg (mR/h)



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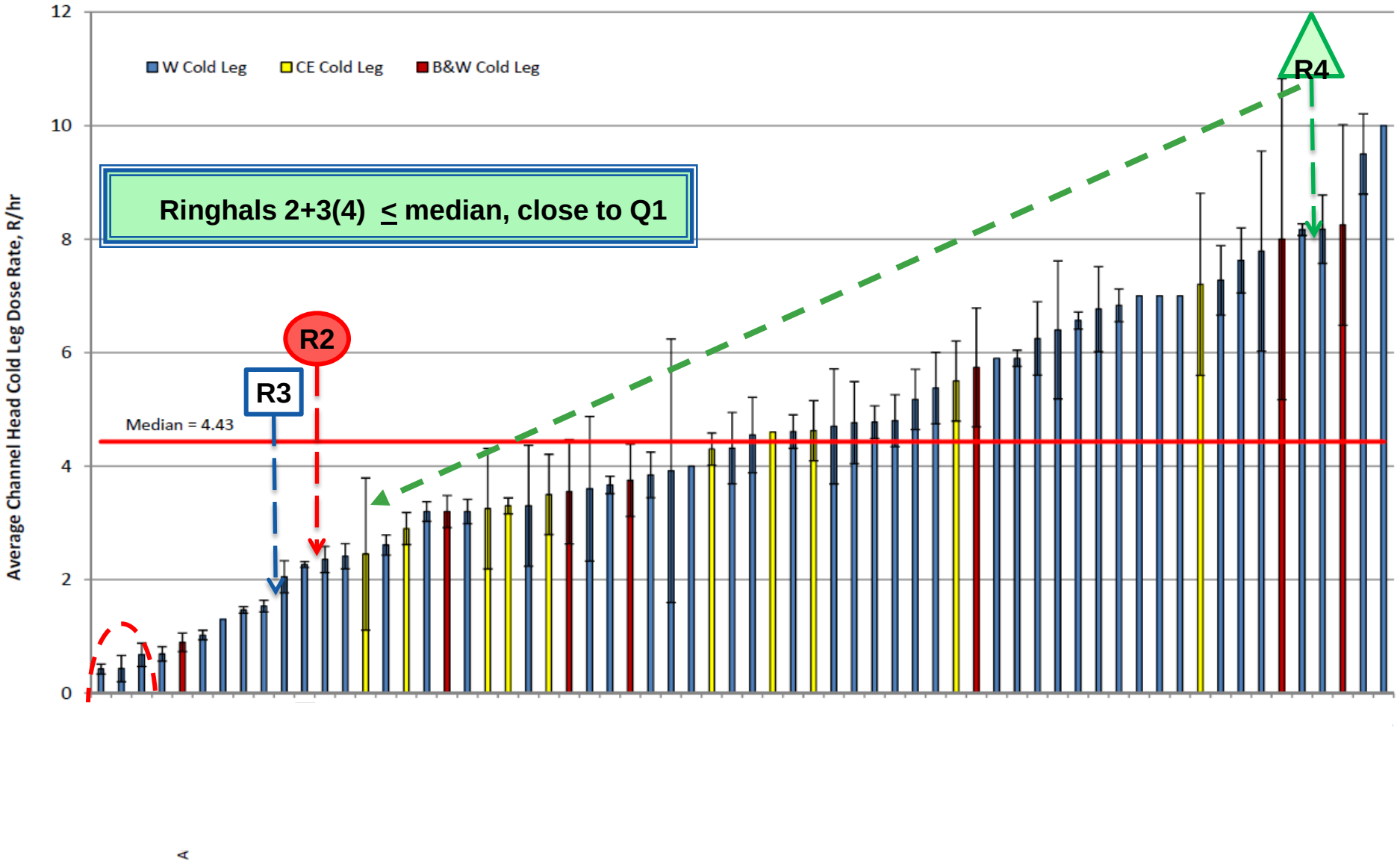

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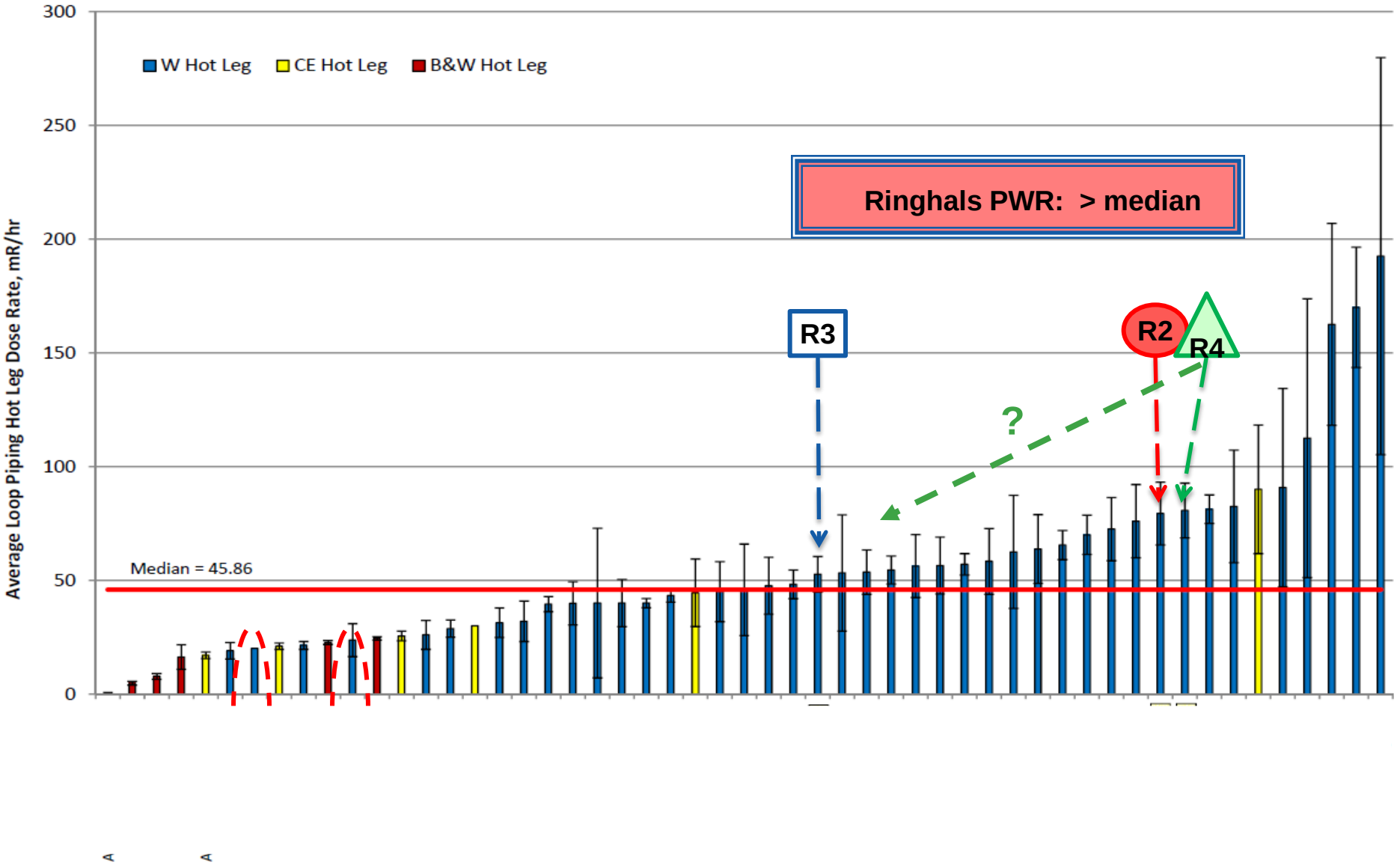
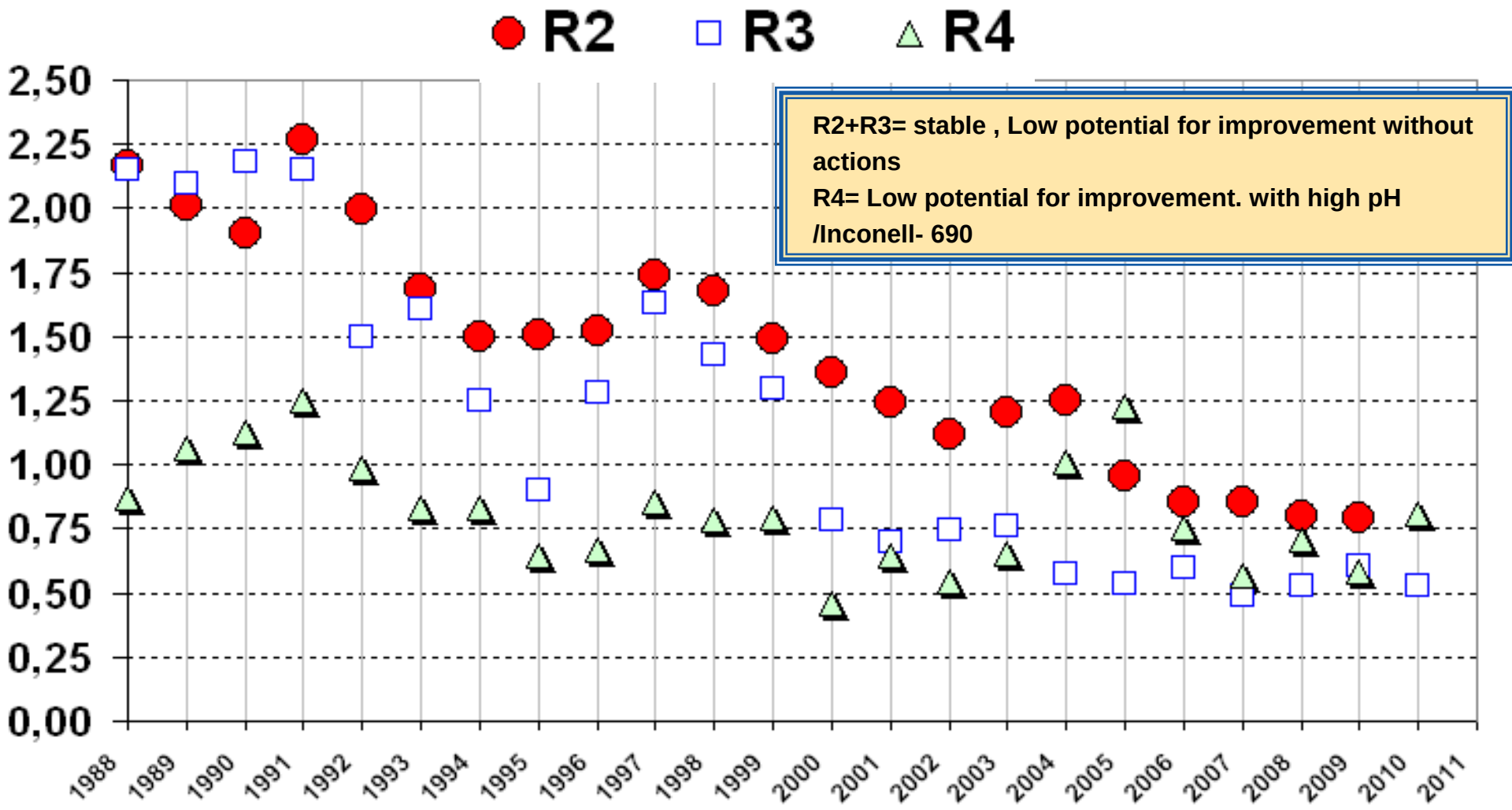


Doserates - Hot Leg Piping (mS/h = x100 mR/h)

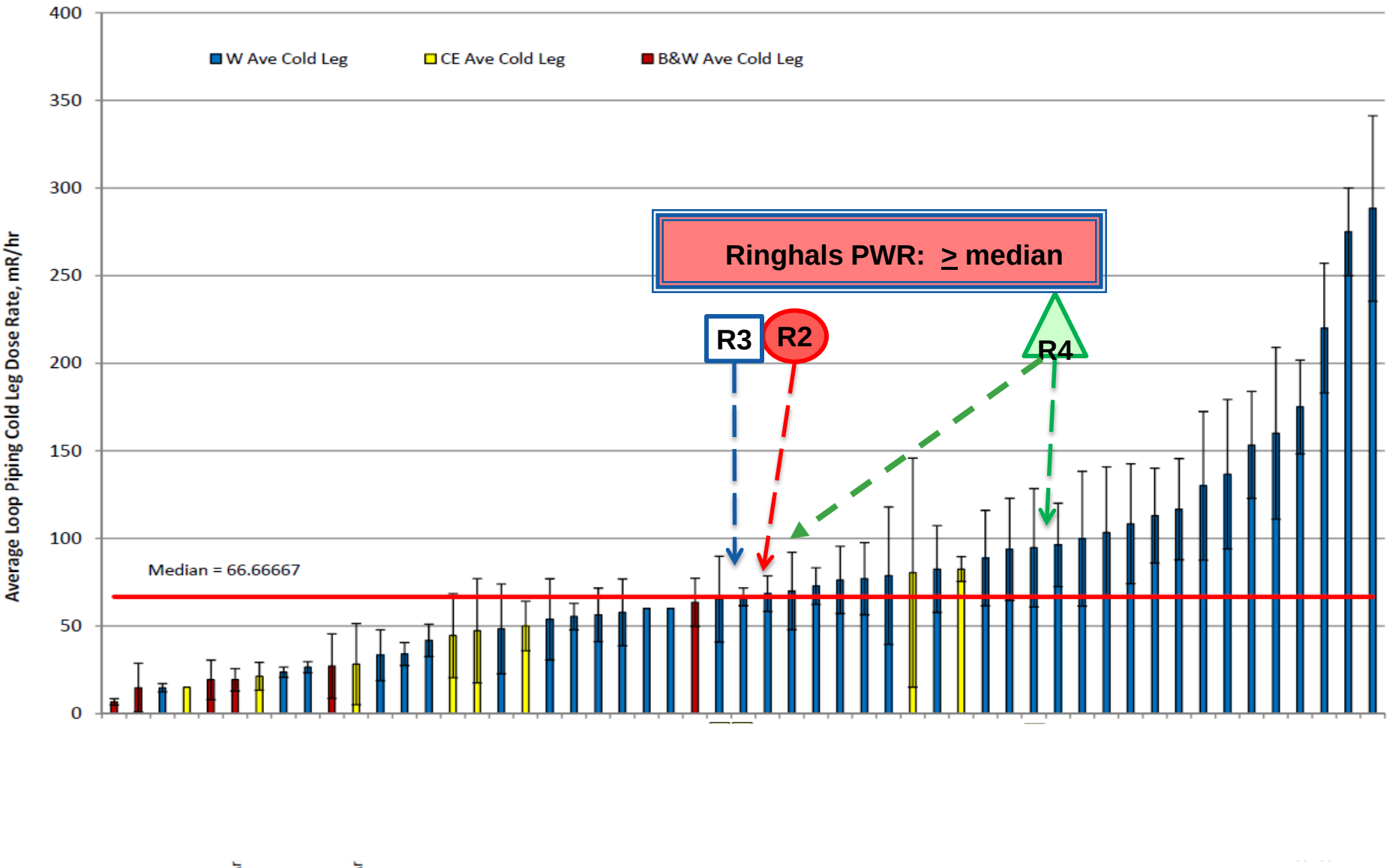


R2+R3= stable , Low potential for improvement without actions

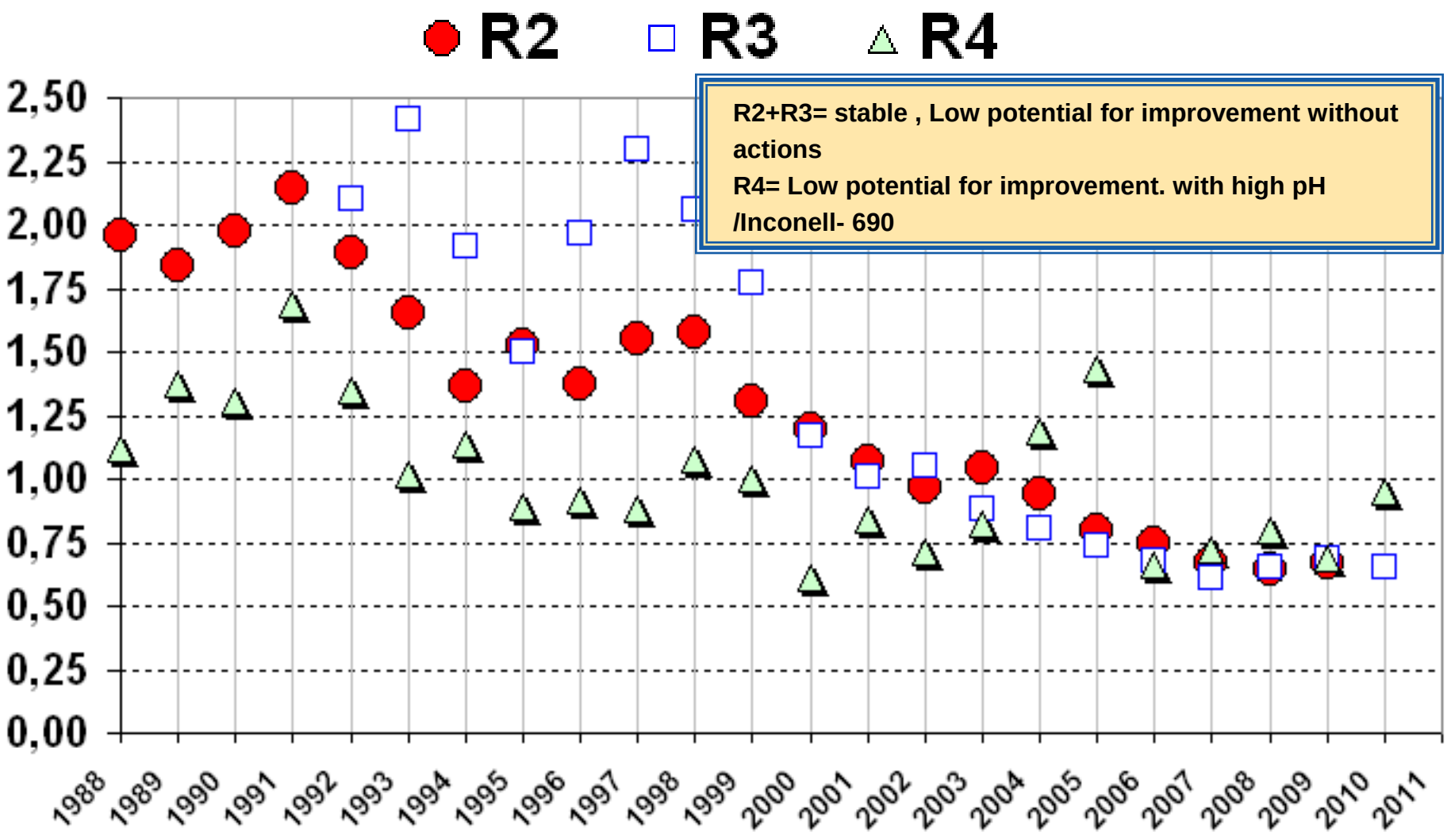
R4= Low potential for improvement. with high pH /Inconell- 690

VATTENFALL

EPRI-SRMP: Cold Leg Piping (mR/h)



Doserates - Cold Leg Piping (mS/h = x100 mR/h)



Conclusions and recomendations

- **Ringhals PWR far away from “No 1”, “WANO-Q1”, “Europe Top Class”**
- **Few possibilities to improve source term reduction without new actions taken**
- **System decontamination on RHR**
- **Zn + HEUFC = costeffective to reach towards lower doserates/doses (^{60}Co)**
- **Fuel analysis are necessery for cycles with high duty core**
- **R4: highest ALARA-potential with HEUFC implemented - Zn delayed due to fuel analysis needed**
- **R3: lowest ALARA-potential / Lowest need of fuel analysis**
- **R2: high ALARA-potential than R3 / Reasonable demands on fuel analysis**

- **START HEUFC at ALL PWR 2013-14**
- **START Zink injection at R2 (+R3) 2013-14, R4 - 2-3 cycles after power uprate**