

RAS 8319

Exl A
1-5

Post-Quench Ductility Results for Zry-4 and M5
Oxidized at 1000°C and 1100°C

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In the matter of Duke Catauba
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Contractor _____ DATE _____
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SECY-02

Table 1 Test Matrix for Oxidation of Samples for Post-Quench Ductility Tests. The times and ECR values listed correspond to those calculated using the Cathcart-Pawel weight gain correlation, a nominal wall thickness of 0.57 mm, and two-sided isothermal oxidation in steam. The relationship between ECR (%) and normalized weight gain (Δw in mg/cm^2) is $\text{ECR} = 1.538 \Delta w$ for 0.57-mm-thick cladding.

| Temperature °C | ECR % | Equivalent Oxidation Time s |
|-------------------|----------|--------------------------------|
| 1000 | 5 | 210 |
| | 10 | 841 |
| | 15 | 1892 |
| | 17 | 2430 |
| | 20 | 3364 |
| 1100 | 5 | 67 |
| | 10 | 266 |
| | 15 | 599 |
| | 17 | 769 |
| | 20 | 1065 |
| 1200 | 5 | 25 |
| | 10 | 99 |
| | 15 | 222 |
| | 17 | 285 |
| | 20 | 394 |
| 1260 | 5 | 14 |
| | 10 | 58 |
| | 15 | 130 |
| | 17 | 167 |
| | 20 | 231 |

Table 2 Weight Gain (Δw in mg/cm^2) and Measured ECR (%) Values for Zry-4 and M5 Oxidized in Steam at 1000°C . For Zry-4, $\text{ECR} = 1.538 \Delta w$, while for M5 $\text{ECR} = 1.437 \Delta w$ because of its thicker wall (0.61 mm vs. 0.57 mm). Alloys were oxidized for the same ramp rate, hold time and cooldown rate for each nominal ECR value.

| Cathcart-Pawel ECR, % | Material | Measured Weight Gain (Δw), mg/cm^2 | Measured ECR, % |
|--------------------------|----------|--|--------------------|
| 5 | Zry-4 | 3.9 | 6.1 |
| 4.7 | M5 | 3.0 | 4.3 |
| 10 | Zry-4 | 7.2 | 11.0 |
| 9.3 | M5 | 5.3 | 7.6 |
| 15 | Zry-4 | 11.0 | 16.9 |
| 14.1 | M5 | 7.4 | 10.7 |
| 17 | Zry-4 | 12.5 | 19.3 |
| 16.0 | M5 | 8.0 | 11.6 |
| 20 | Zry-4 | 14.6 | 22.4 |
| 18.8 | M5 | 9.2 | 13.3 |
| 20.7* | M5 | 8.6 | 12.4 |

*Post-quench confirmation test sample generated at an equivalent time of ≈ 4100 s; note that the weight gain decreased from 9.3 to $8.6 \text{ mg}/\text{cm}^2$ with the increase of 700 s in oxidation time. Both samples exhibited smooth, black oxide layers with no indication of spallation.