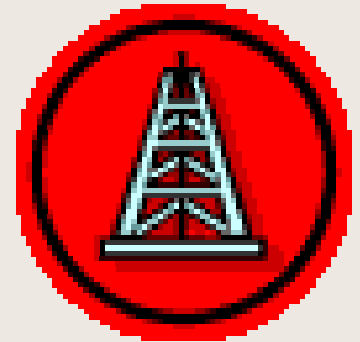


A spiral-bound notebook with a light beige, textured cover. The metal spiral binding is on the left side. The title "Radiation Effects on Materials" is printed in a black serif font in the center of the cover.

Radiation Effects on Materials

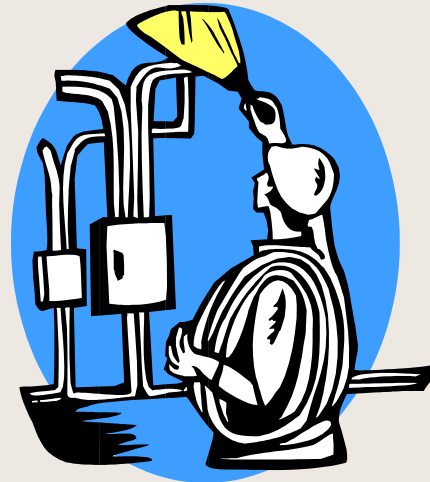
Effects of Radiation on Material

- Gamma, fast neutrons, slow neutrons
 - Cause damage to materials by unique mechanisms
- Oils and soap based greases
 - Oils get stiffer
 - Soap based greases get less viscous
- Plastics
 - Embrittlement if the molecules are complex



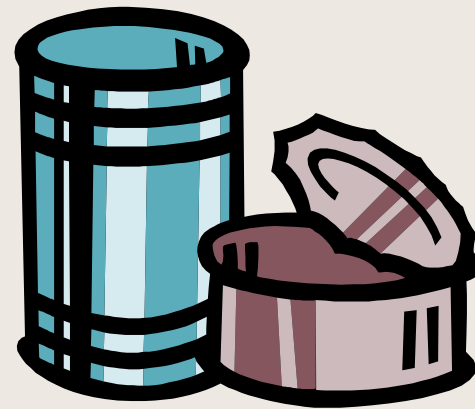
Effects on Plastic

- Plastics
 - Embrittlement if the molecules get more complex
 - Lose strength if the molecules get shorter
 - Decompose to gas



Effects on Metals

- Ultimate tensile strength ↑
- Yield strength ↑
- Hardness ↑
- Ductility ↓



Effects on Concrete

- Radiation heats the concrete
- Heat drives out water
- Loss of of water had two effects
 - Spalling and cracking of the concrete
 - Lowering of shield effectiveness



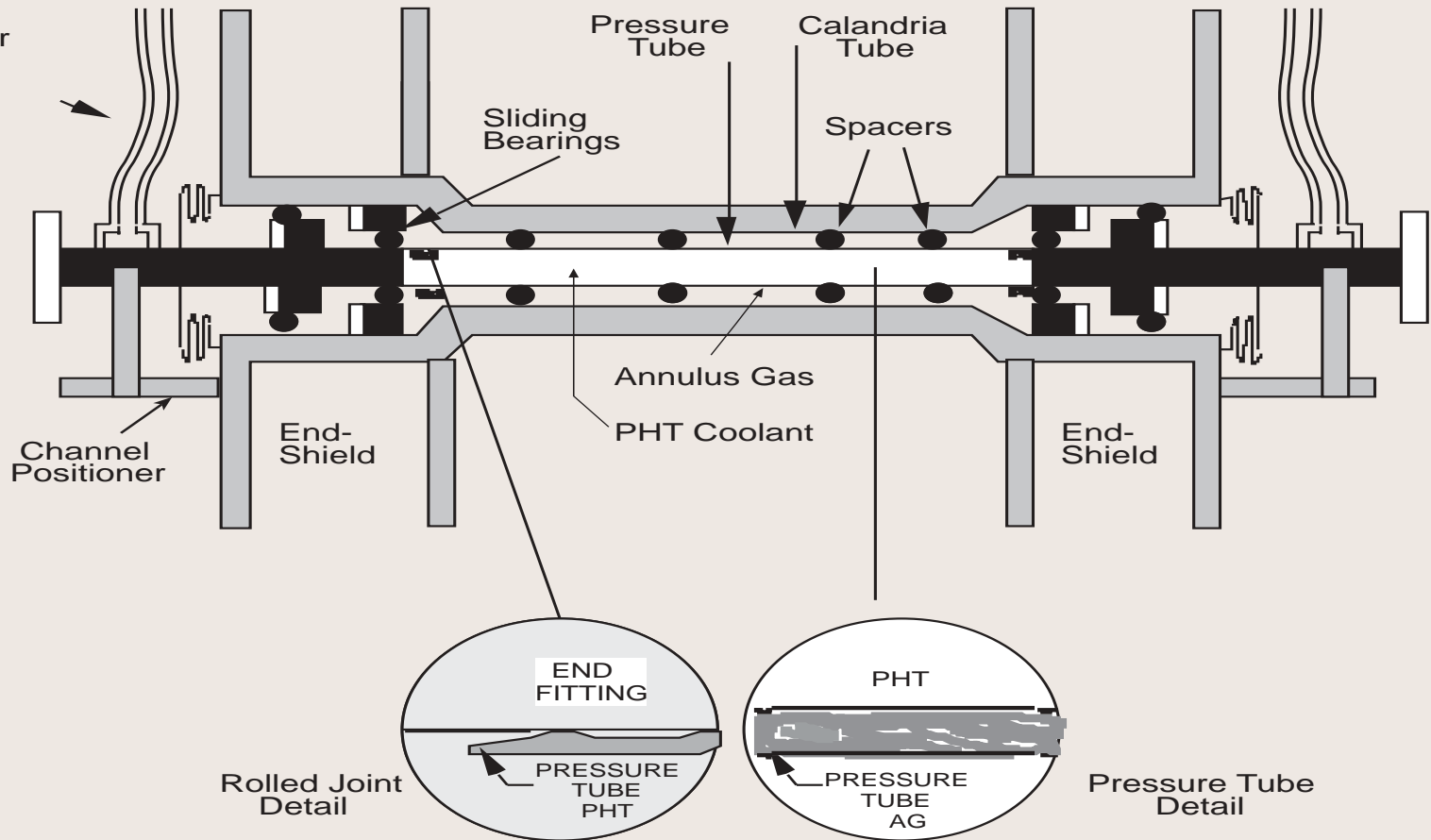
A spiral-bound notebook with a light beige, textured cover. The spiral binding is on the left side. The text "Pressure Tubes" is centered on the cover in a black serif font.

Pressure Tubes


2 Effects

- Pressure tubes get longer
- Pressure tubes get brittle

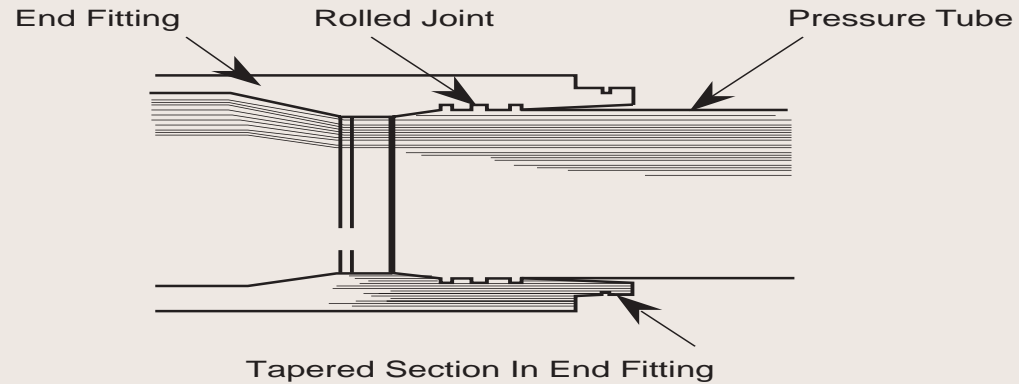
Pressure Tube Schematic



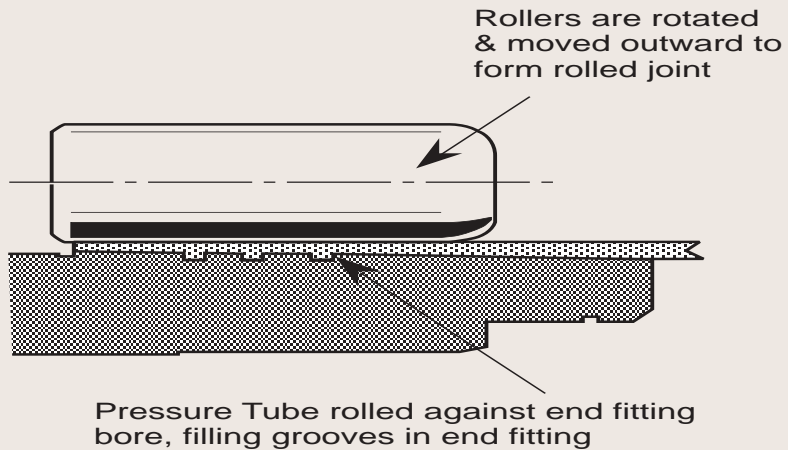
Delayed Hydride Cracking

- A very bad thing
- Hydrogen in a tube 
 - Migrates to areas of high stress
 - Stays in-solution at high temps
 - Forms brittle deuterium hydride when cooled
- Stress occurs at rolled joints

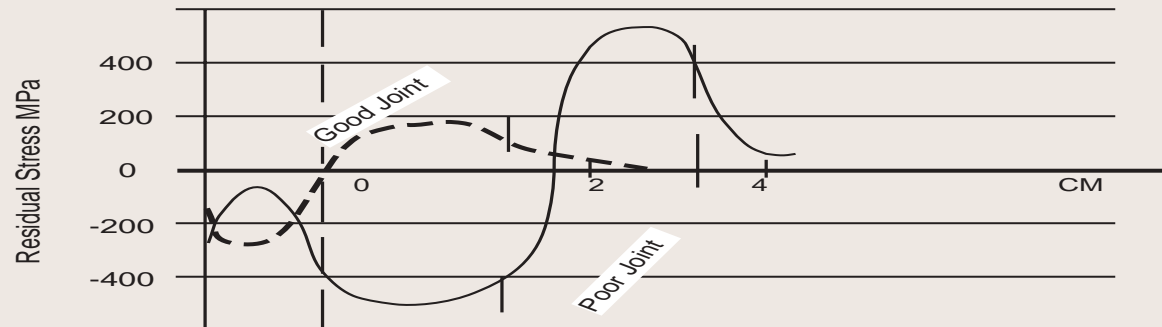
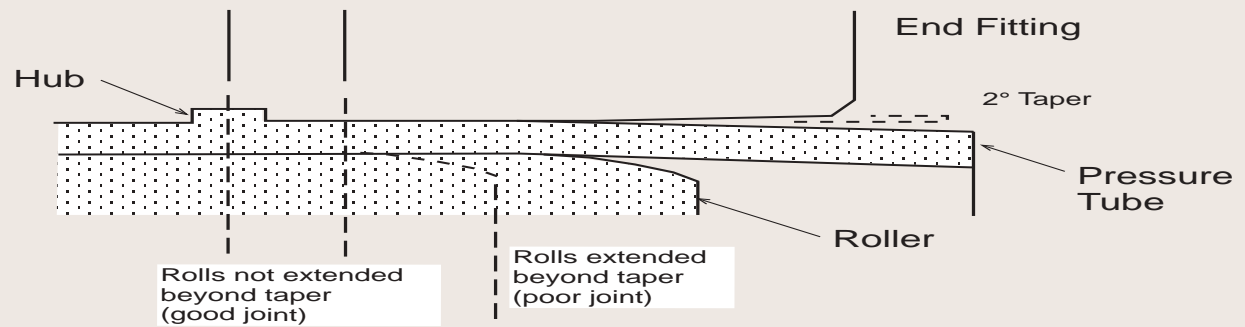
Rolled Joints



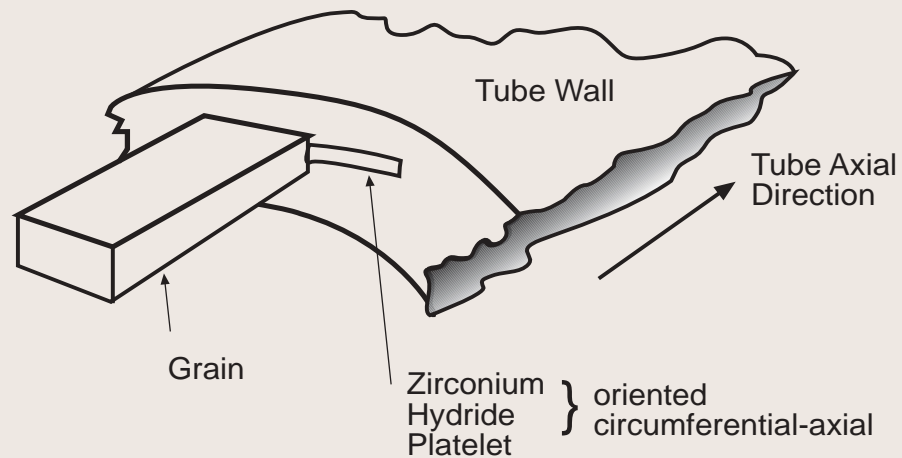
Rolling



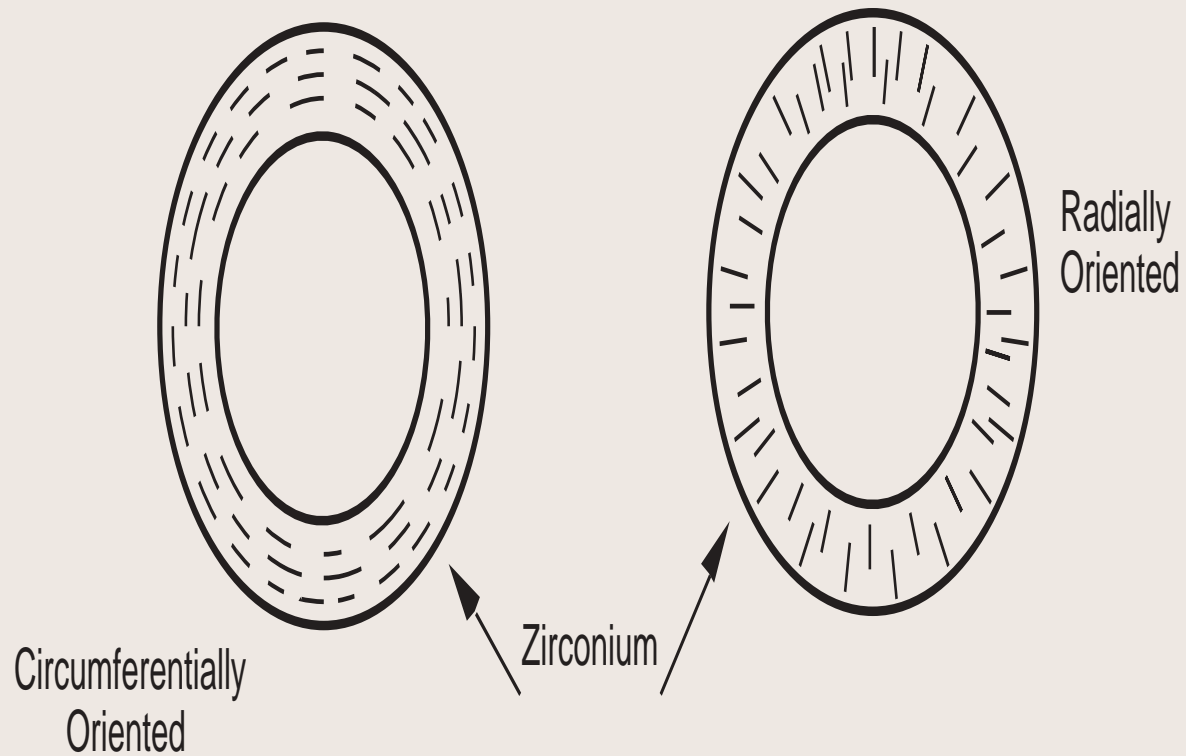
Stresses at Rolled Joints



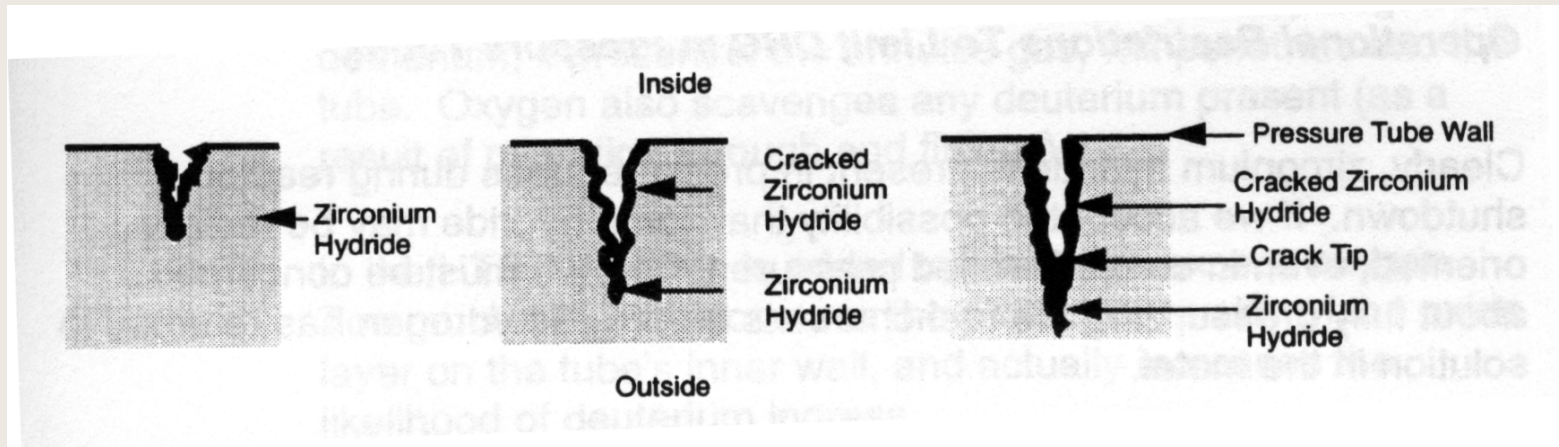
Zirconium Hydride Platelets



Platelet Orientation



Crack Growth

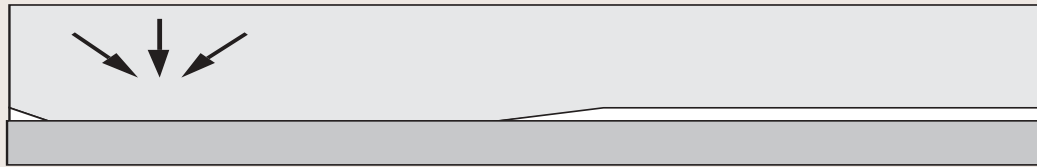


What is done

- Sampling to keep track of H₂ in tubes
- Warm up and pressurizing procedure
 - Don't apply full pressure on a cold tube
 - Warm up quickly to dissolve hydrogen

Blistering

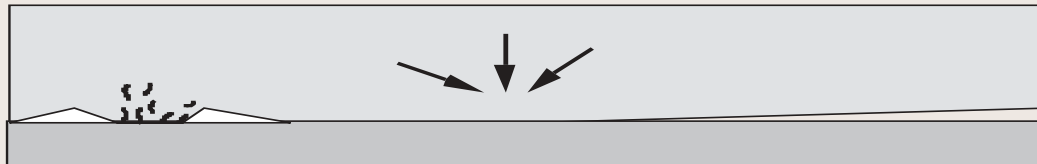
PROBABLE SEQUENCE OF CRACK DEVELOPMENT
FROM PRESSURE TUBE (PT)/CALANDRIA TUBE (CT)



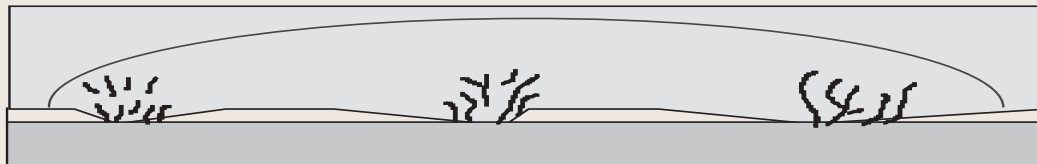
(1) Cold spot developed on PT from contact with CT causing H_2/D_2 diffusion to cold spot



(2) Blister develops and cracks from volume expansion of hydride



(3) PT sags, blister indents the calandria tube and PT contacts at another spot down the tube



(4) Cracks, developed from blisters, link up and grow to an unstable size.

For You to Do

- Read the section on radiation damage pp. 41-52
- Answer questions p. 53