



Qualification by Testing of Pressure Tubes - Summary -

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Outline

- **Qualification of production**
- **Qualification of properties**
- **Quality**



Qualification of Production

- **Definition of requirements**
- **Assessment of changes to production route necessary to achieve requirements**
- **Discussion with manufacturers**
- **Production of developmental or prototype tubes**
- **Assessment of production**
- **Definition of production qualification**
- **Production of qualification tubes**
- **Assessments against requirements**
- **Documentation**
- **Full scale production**



Qualification of Properties

- **Properties of as-manufactured tubes**
 - **Chemical composition**
 - **Strength and ductility testing**
 - **Axial and transverse tensile properties**
 - **Fracture toughness testing**
 - **Initiation toughness and dJ/da measurements**
 - **Delayed hydride cracking response**
 - **K_{1H} and DHC velocity**
 - **Microstructure**
 - **Grain structure, crystallographic texture, dislocation density, beta phase Nb concentration**



Qualification of Properties

- **Properties after irradiation**
 - Strength and ductility
 - Toughness
 - DHC
- **Builds upon past experience**
 - Irradiation to end-of-life neutron fluence levels not required



Irradiation Response

- **Periodically monitor changes during irradiation program**
 - Corrosion and hydrogen ingress tests
 - Irradiation creep and growth tests
- **Compare results with expected behavior**



Quality Program

- **Documentation at all stages of program**
 - **Design of program including all verification requirements with reference to quality standards for design qualification, e.g.**
 - **Component Verification Specifications**
 - **Inspection and Test Plans**
 - All procedures identified
 - **Test Reports**
 - **Analysis / Assessment reports**
 - **Design reviews at various stages**
 - **Other steps as appropriate**



ACR Pressure Tube Qualification Program

- **Builds upon past experience in industry**
- **Designed to provide supporting data to meet implementation requirements**
 - **As-manufactured**
 - **After irradiation**
- **Good quality process**



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