



A Simplified Approach for Predicting Containment Performance During a Severe Accident

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Outline

- Background
- Testing and analysis of concrete containments
 - Reinforced concrete
 - Prestressed concrete
- Containment leakage
- Conclusions



Background

- State of the Art Reactor Consequence Analysis (SOARCA)
- Containment performance input for SOARCA
- Containment scale model tests and analyses
 - Sandia National Laboratories (SNL)
 - Central Electricity Generating Board
- Severe accident analysis use different and arbitrary criteria for containment leakage.
- Need for a simple and consistent approach



Reinforced Concrete Containment

- 1:6 scale containment test at Sandia
- Containment yield and leakage
 - Excessive Leakage (10% of Containment Mass Per Day) After Liner Plate and Rebars Yield
 - Leakage More Than 100% of Containment Mass Per Day at Global Strains of 2%
- Catastrophic containment failure not possible
- Round robin analyses
- Simplified analysis
- Comparison of results



1:6-Scale Reinforced Concrete Containment Test

Source	Hoop rebar and liner plate yield MPa (psig)	Containment failure MPa (psig) (Leakage >100%/day)
Round robin analyses (Maximum)	0.951 (138)	1.276 (185)
Round robin analyses (Minimum)	0.827 (120)	0.883 (128)
Round robin analyses (average)	0.869 (126)	1.076 (156)
Test data	0.820 (119)	1.00 (145)
Proposed simplified analysis	0.876 (127)	0.986 (143)



Existing Reinforced Concrete PWR Containments

Item	Containment #1	Containment #2	Containment #3
Internal pressure at rebar and liner plate yield from IPE reports MPa (psig)	0.758 (110)	1.000 (145)	1.248 (181)
Internal pressure at failure from IPE Report MPa (psig)	1.062 (154)	1.048 (152)	1.489 (216)
Internal pressure at rebar and liner plate yield from simplified analysis MPa (psig)	0.779 (113)	0.848 (123)	1.062 (154)
Internal pressure at failure simplified analysis MPa (psig)	0.855 (124)	0.958 (139)	1.200 (174)



1:4-Scale Prestressed Concrete Containment Pressure Test

Source	Hoop rebar and liner plate yield MPa (psig)	Containment failure MPa (psig) (Leakage >100%/day)
Round robin analyses (Maximum)	1.248 (181)	1.979 (287)
Round robin analyses (Minimum)	0.855 (124)	0.814 (118)
Round robin analyses (average)	1.034 (150)	1.413 (205)
Test data	1.055 (153)	1.296 (188)
Proposed simplified analysis	1.062 (154)	1.331(193)



1:10-Scale Prestressed Concrete Containment Pressure Test

Item	Test result	Proposed simplified approach	3-D analysis
Internal pressure at rebar yield MPa (psig)	0.586 (85)	0.683 (99)	0.662 (96)
Internal pressure at failure MPa (psig) (leakage > 100%)	0.772 (112)	0.738 (107)	0.738 (107)



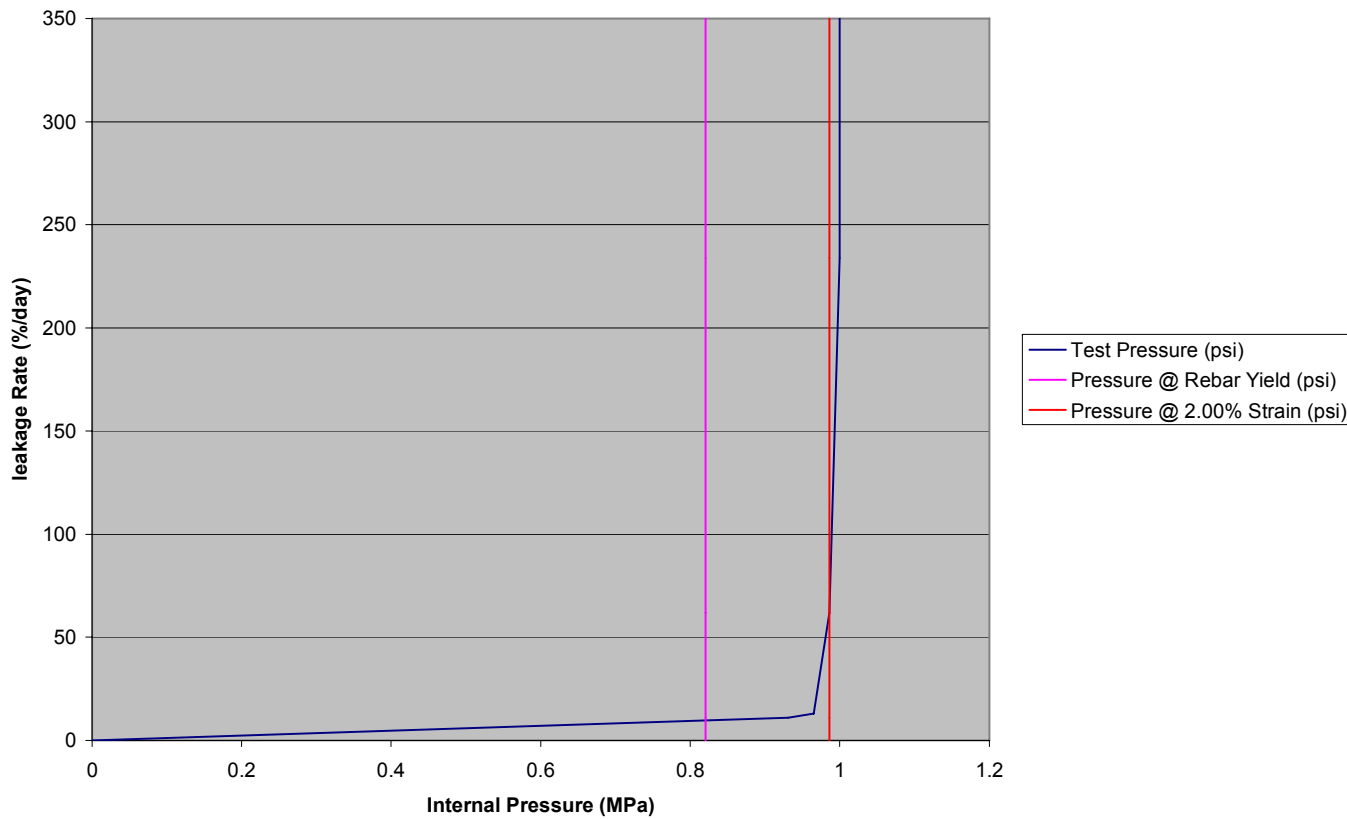
Containment Leakage

- Containment severe accident analysis require prediction of leakage rate.
- Lack of experimental data
- Uncertainties in detailed finite analysis
- Location of leakage
- Use available data to determine impact on the severe accident analysis outcome



1:6 Scale Model Containment Leakage

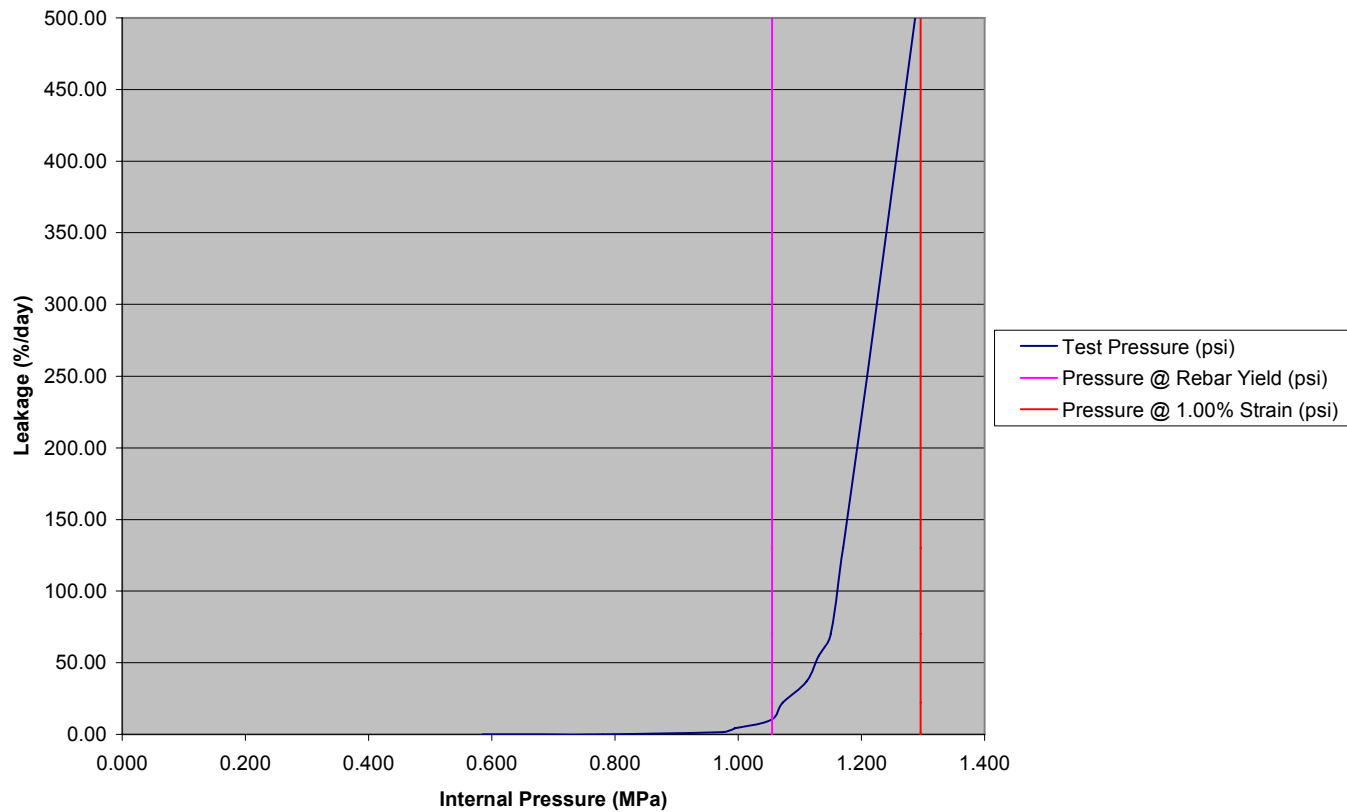
1:6 Scale Reinforced Containment Test Pressure vs. Leakage





1:4 Scale Model Prestressed Concrete Containment Leakage

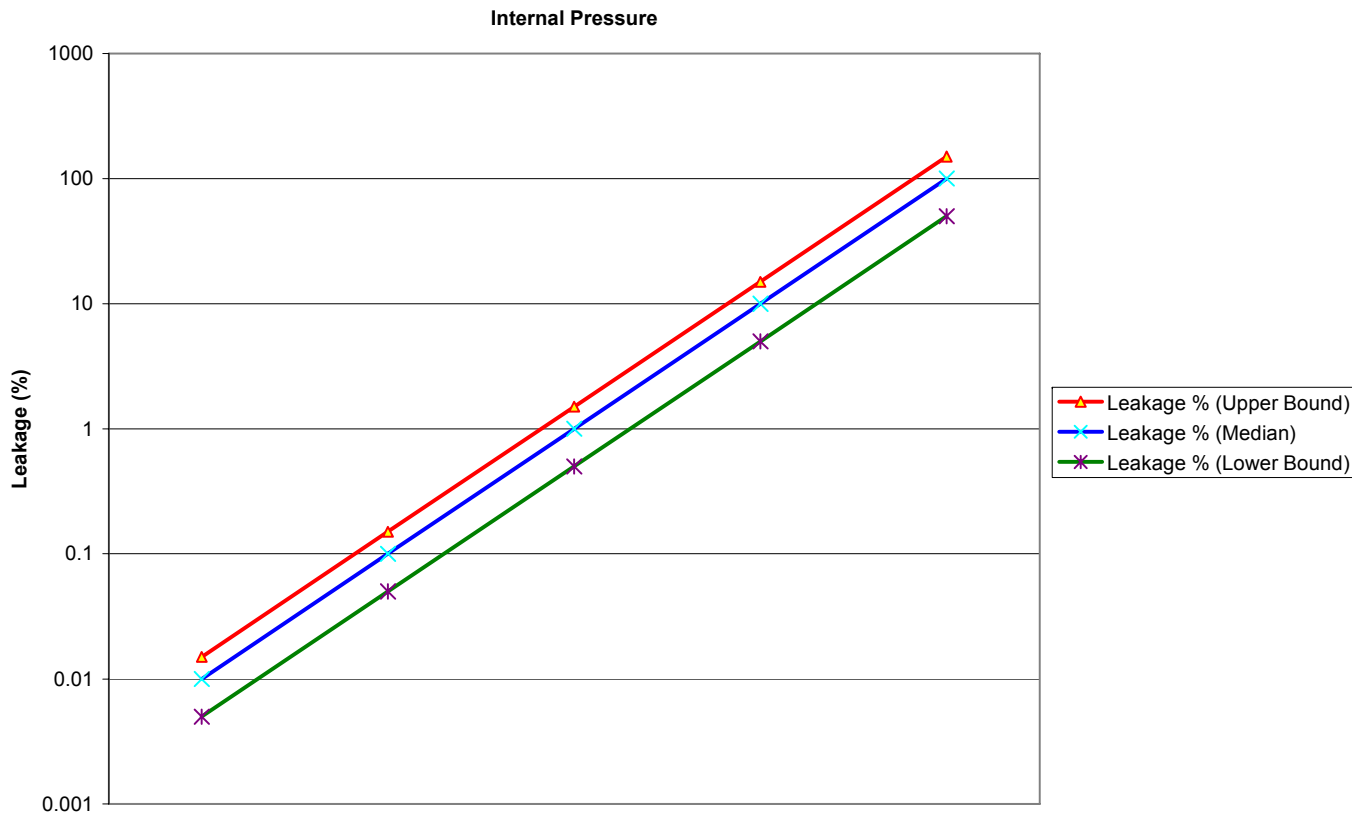
1:4 Scale Prestressed Concrete Containment Pressure vs. Leakage





Proposed Internal Pressure and Leakage Relationship

Containment Leakage vs. Internal Pressure





Conclusion

- The proposed relationship for leakage rate and internal pressure is based on interpretation of the results of 25 years of testing and analysis of containments.
- Further refinements may be necessary if the results of the severe accident sensitivity analysis show that containment performance data has a significant impact on the final dose rate.