STANDARD PROBLEM EXERCISE (SPE-3) ON PERFORMANCE OF CONTAINMENT VESSEL UNDER SEVERE ACCIDENT CONDITIONS

Phase-2

Part- II: Probabilistic study of Leakage rate estimation

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Outline of the Presentation

- **Introduction**
- **Methodology**
- **Results**
- **Conclusions**

Introduction

Objectives of Phase-2:part-II of SPE-3

- Estimation of leakage rate through PCCV
- Transform the leakage rate estimation to probabilistic space

The probabilistic study of leakage rate is done for PCCV under internal pressure load only

Methodology

Parameters that <u>can</u> be considered for probabilistic analysis

- Material property variation

  - Concrete, reinforcing steel, prestressing cable, liner

- geometry

- Force

  - Prestress: losses, dilation effect

- Leakage rate

  - Formulations other than Rizkalla et.al.

- Additional parameters as used in empirical equation of leakage rate calculation

Methodology

- An attempt has been made to do this exercise based on variations of liner properties and concrete tensile strength while estimating the leakage rate.
- Parameters currently considered (based on leakage study) are as described in earlier presentation, viz.

  - liner damage initiation strain based on Jcr

  - liner damage factor (DF)

  - maximum tensile stress of concrete (f_t')

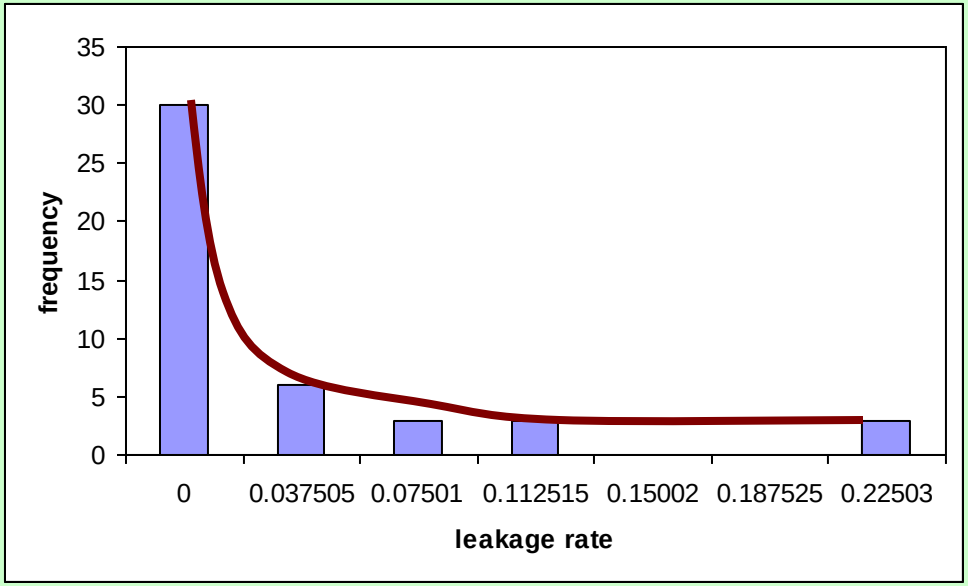
Methodology

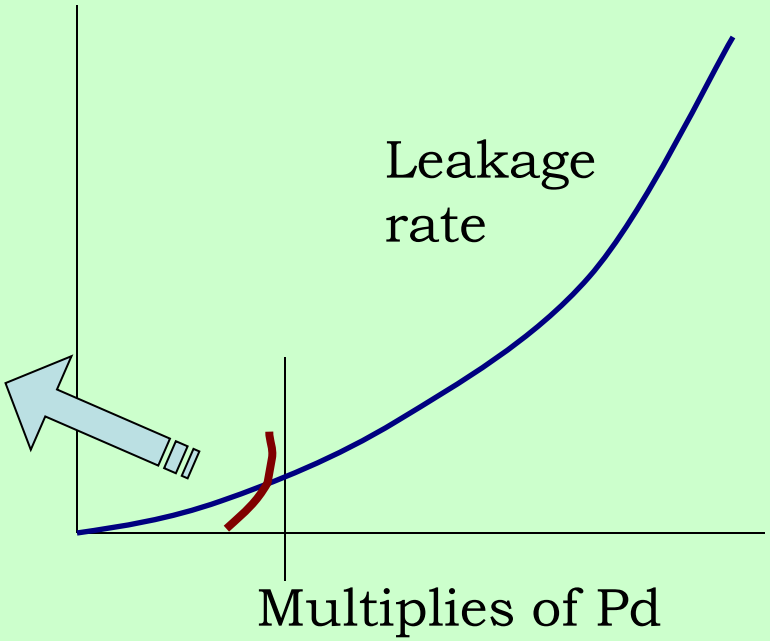
- Jcr of liner strain: 200, 350 and 500 in-lbs/sq in (variations as described in earlier presentation)
- Five different variations of DF of liner, viz. 1.0 (linear), [1.25, 1.5, 1.75 (power)] and 2.0 (parabolic) (pattern of DF has major influence).
- f_t' of concrete : 2.11, 2.48 and 2.85 MPa

  Experimental data of concrete compressive strength at different pour/level of PCCV wall were found to vary ± 15%. It was assumed the tensile strength of concrete would also vary in similar manner. Analysis of 3D FE model was done using mean fc' as 2.48MPa only.
- Total 3 x 5 x 3 = 45 combinations

Methodology

Histogram

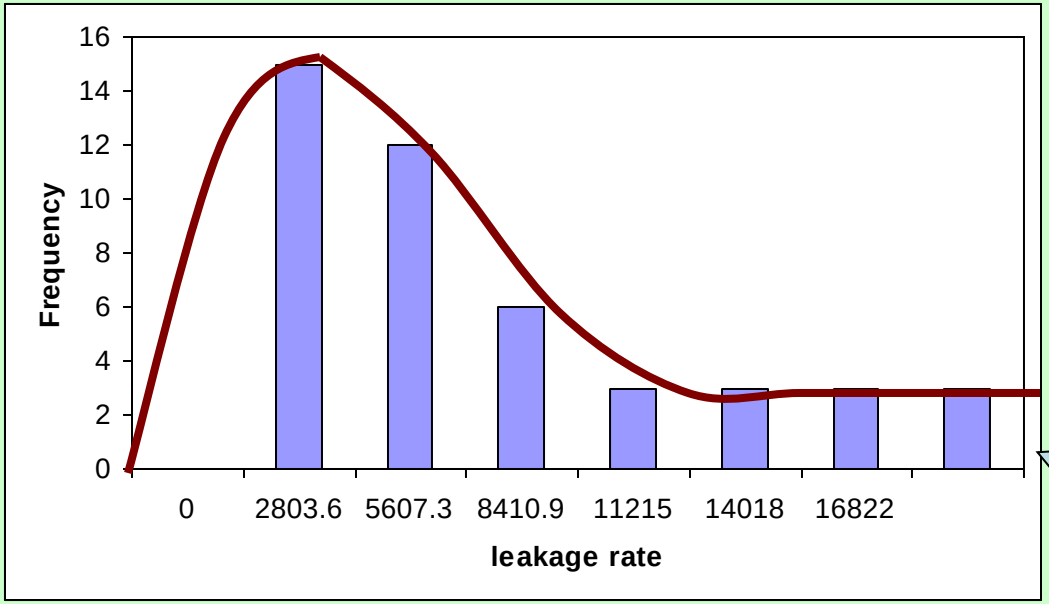


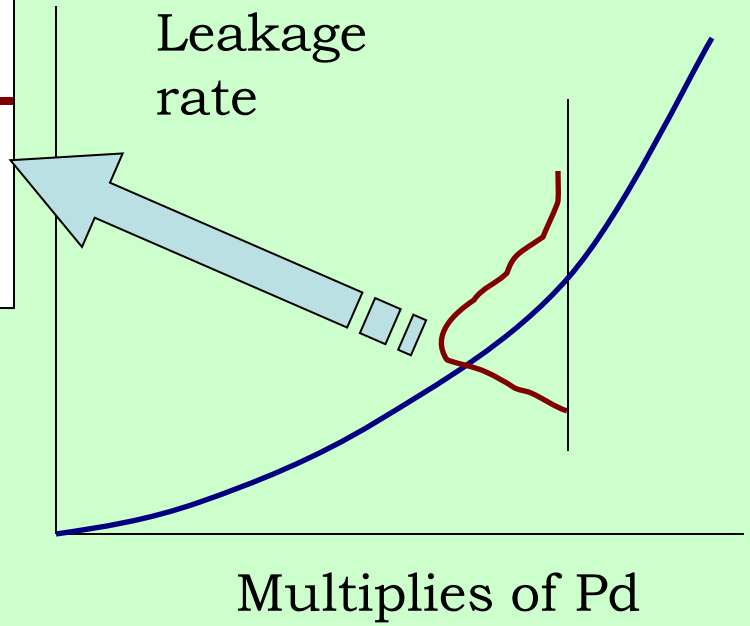


At lower pressure
≈ 2.6 Pd

Methodology

Histogram

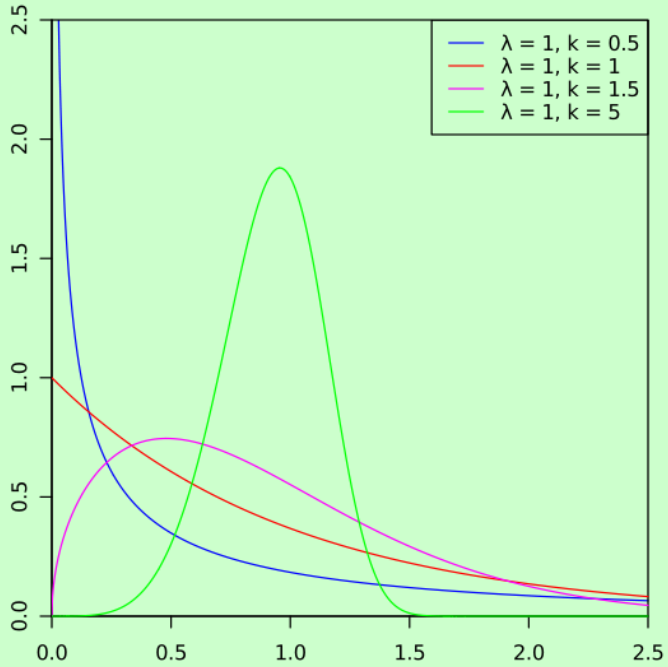




At higher pressure
≈ 3.59 Pd

Methodology

- Total 36 pressure load steps (from 2.6 Pd) were considered and each load step consisted of 45 values of leakage rate.
- Based on histogram plot of variation of data for a particular load step, Weibull distribution was fit.



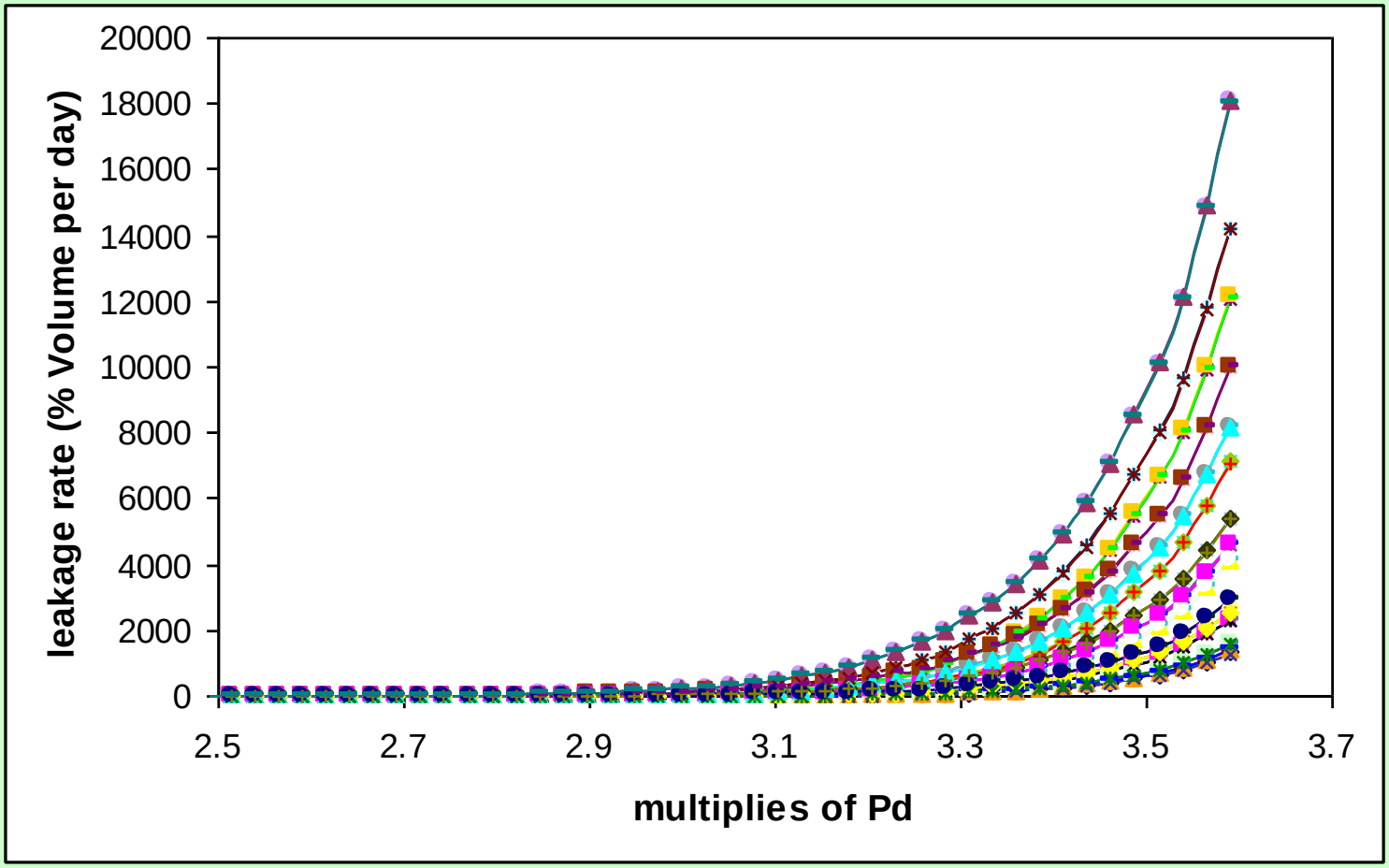
$$f(x) = \frac{k}{\lambda}\left(\frac{x}{\lambda}\right)^{k-1} e^{-\left(\frac{x}{\lambda}\right)^{k}}$$

k = shape factor

λ = scale factor

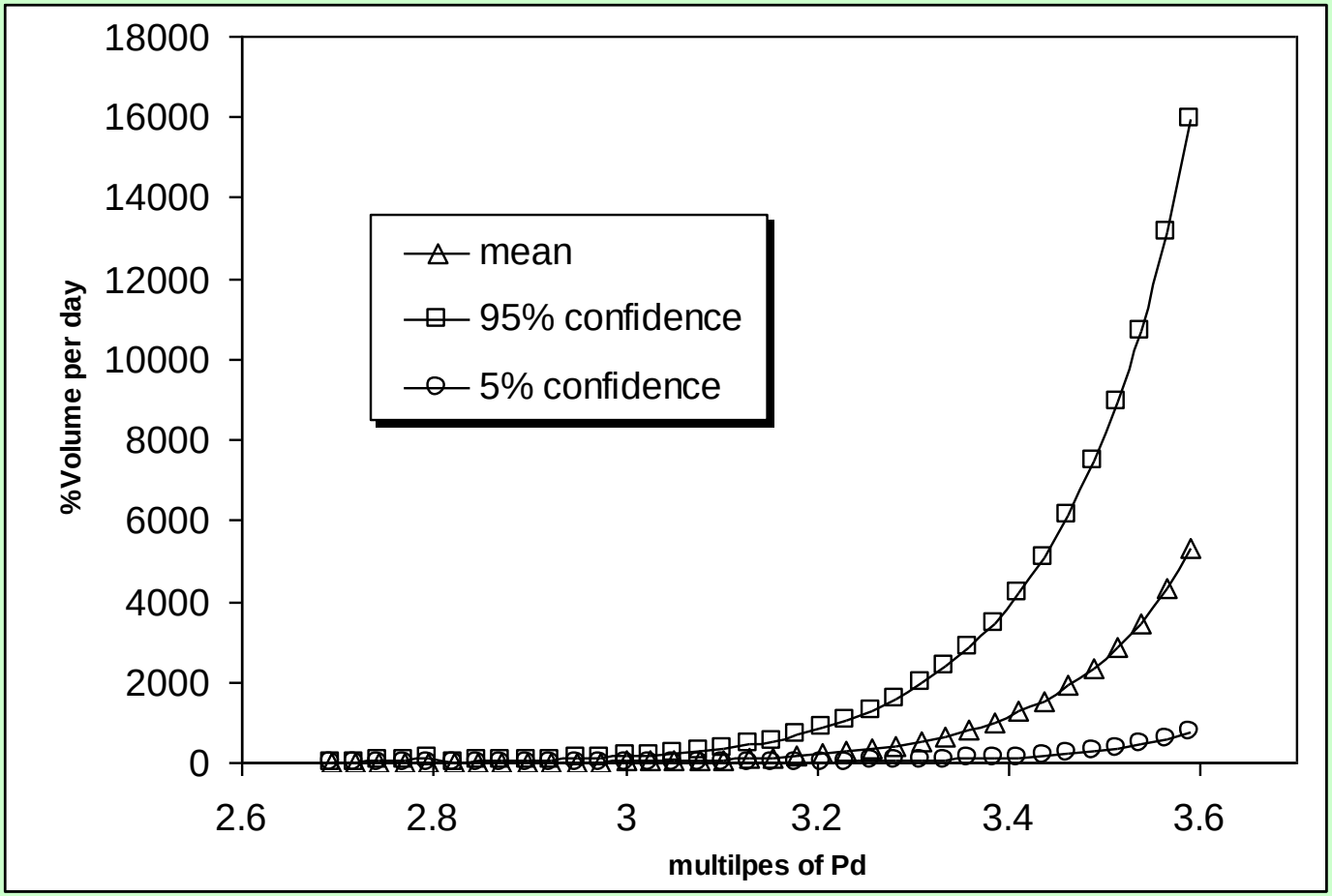
Results

Predicted leakage rate considering variations in input



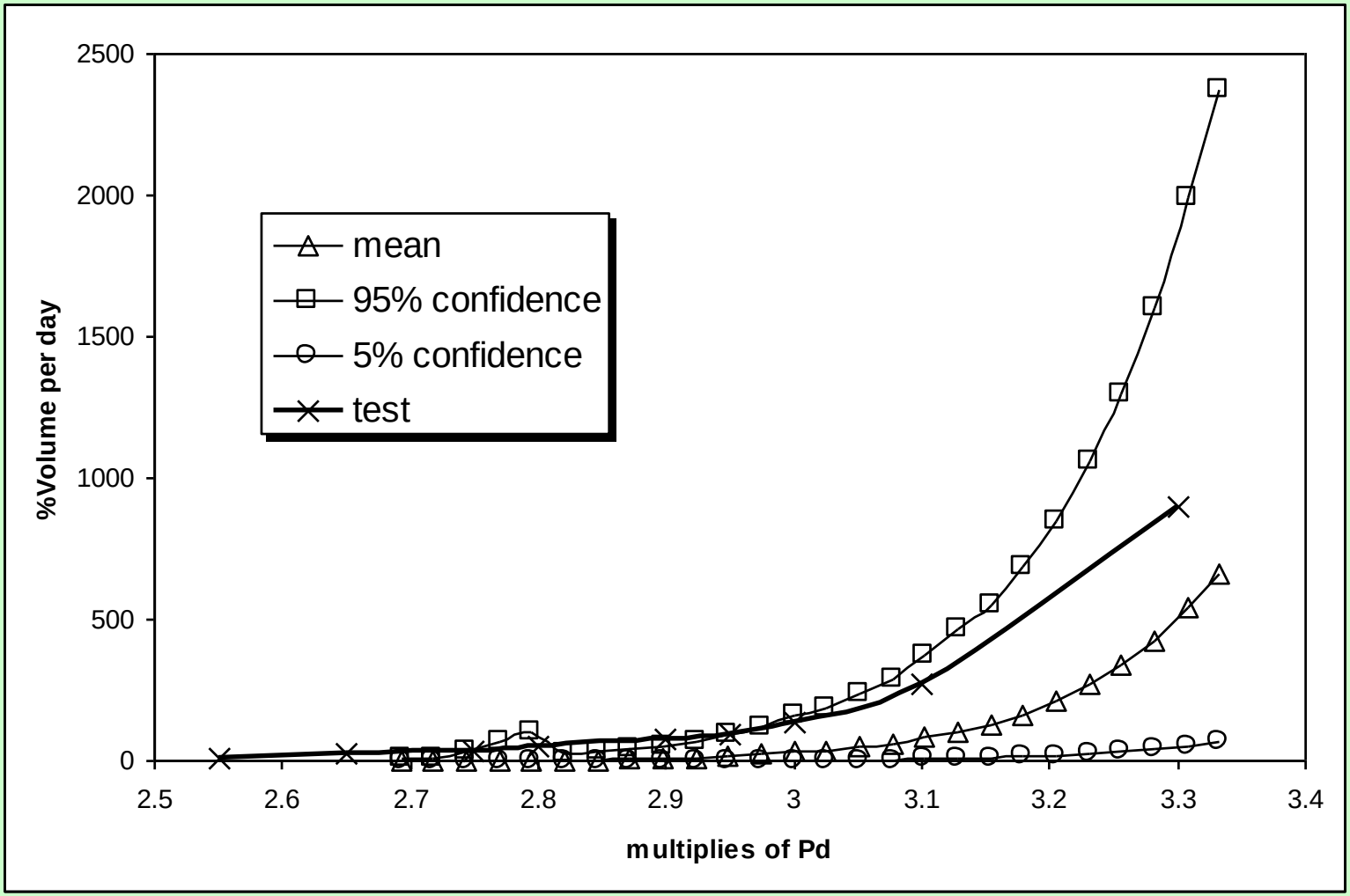
Results

The leakage rate calculated for mean, 95% and 5% confidence



Results

Comparison with test results also



Conclusion

- Probabilistic study (limited scope) shows that test value of leakage rate is near to 95% confidence value.

  - This may need updating the leakage prediction model and/or need a detailed parametric study.

- The leakage study shows that test results lies between leakage curve of DF 1.0 and 1.5, may be close to 1.2 or 1.3. So, more data needs to be generated in this area.

- Other statistical model

Thank You