Sample Cue Cards Prepared for PowerPoint® Presentation #1 "Measurement of Membrane Fouling in Spiral-Wound Modules"

1. **Title slide**
   - 1 out of 6 people in world has no potable water
   - Amounts to 1.1 billion people
   - Water covers 71% of earth - most is salt water
   - RO can turn this into fresh water
   - RO expensive because of membrane fouling
   - Focus of talk
2. **Overview**
   - Mention slides numbered on header
   - Define acronyms
3. **Definition of fouling**
4. **Importance of fouling**
   - Belfort said in 1984 still true today
5. **Impact on RO desalination**
   - 2000 data base used for facts & figures
   - Reason for high cost of RO
6. **Measurement of fouling**
   - Define direct & indirect fouling measures
   - Define acronyms – NMR & EDX
7. **Technological barriers**
   - Direct impractical for commercial applications (NMR)
   - Indirect also measure other things (compaction, CP)
8. **Objectives**
9. **UTDR chronology**
   - UTDR an old technology
   - Our group pioneered application to membranes
   - Indicate seminal papers
10. **Principle of ultrasound measurement**
    - Defend use of animation
    - Describe acoustic transducer
    - Define axes
    - Describe effect of fouling layer
    - UTDR in real module not simple
11. **Spiral-wound membrane module**
    - Schematic
    - Describe various layers
    - Multiple reflections
12. **Methodology**
    - Analogy of using signature to determine intoxication
    - Define axes
    - Unfouled & fouled module waveforms
    - Amplitude/arrival time for unfouled & fouled membrane
13. **Analysis of UTDR signal**
    - Apology for showing equations
    - Define symbols

14. Experiment conditions

- Commercial membrane module
- $CaSO_4$ solubility – 2 g/L
- Long run time

15. Results – spiral-wound module

- Define axes on both plots
- Describe normalization
- Describe equilibration/fouling/cleaning protocol
- Define abbreviation WE
- Describe amplitude/arrival time plots
- Describe flux plot
- Replicate experiments to assess error
- Explain metrics not returning to those for unfouled membrane

16. Corroboration with SEM analysis

- SEMs at different points along & within module
- Indicate length scale
- Indicate spacer
- Describe appearance of scaling deposits
- Higher mag SEM showing $CaSO_4$ crystals
- Indicate length scale

17. Conclusions

- Indicate 3 objectives achieved
- Acoustic signature useful for deconvoluting UTDR signal
- UTDR corroborates with permeate flux & SEM analyses
- Other conclusions relate to unexpected results
- Fouling deposition spatially non-uniform
- UTDR useful to optimize spiral-wound module design

18. Acknowledgments

19. Thank You slide

- Thank audience for their attention
- Point out Email address