Strengthening the Houston Ozone Modeling to Address the Lower 8-hr NAAQS

presented to

Southeast Texas Photochemical Modeling Technical Committee (SETPMTC)

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Overview

- The 8-hr Coalition's science program is focused specifically on the attainment problems of the Houston-Galveston-Brazoria area.
- The tools and study results are intended to serve as a technically complete and compelling justification for establishing precursor control requirements under a lower NAAQS.
- This program is an open-process and encourages the participation and collaboration of TCEQ and EPA modeling experts along with other researchers and stakeholder groups.
- The results of the Coalition's modeling efforts will be compared with the TCEQ's planned SIP modeling work (when both are completed) to afford the strongest possible weight-of-evidence support in the ramp-up to the next SIP.

Key Elements of an Intensified Ozone Modeling Approach for Houston

- **Address the Dual-Ozone Problem**
  - 'Typical' ozone formation: Use state-of-science tools and regulatory inventories to model typical ozone formation.
  - 'Non-Typical' ozone formation: Use modeling tools with specialized inventories that include NTOC phenomena and corroborate with high-resolution measurements.
  - This separation of ozone formation into two categories was used in TCEQ's 2004 SIP and approved by EPA.
- **Use Multiple Modeling Tools**
  - Provides stronger foundation to determine VOC & NOx reductions required for attainment.
  - Offers stronger justification for a Houston-specific approach.
- **Model Attainment Consistent with Form of NAAQS**
  - Current modeling science and high performance computing allows direct comparison of future ozone predictions with the NAAQS.

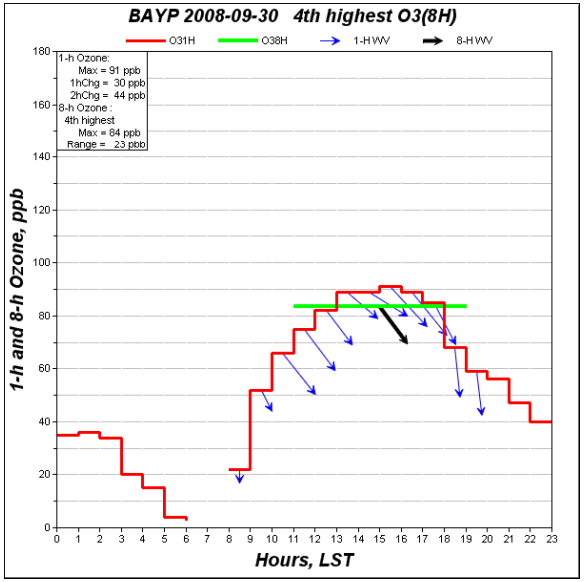
What are the Challenges for Houston?

- Under any lower O_3 standard, TCEQ & EPA modeling suggests nearly impossible control requirements for all sources in Houston.
- Emissions controls beyond 2018/2020 levels have far-reaching implications for economic viability, jobs and lifestyle choices.
- In Houston, use of EPA's default RRF approach and omission of unique NTOC phenomena, leads to DV_F's that are as much as 11 ppb higher at key monitors compared to the dual-O_3 paradigm.
- EPA has no announced plans to modernize its SIP modeling method; TCEQ resources will be stretched to address many new nonattainment areas.
- Interstate and international transport, under the lowered NAAQS, will play an increasingly larger role in Houston attainment efforts.

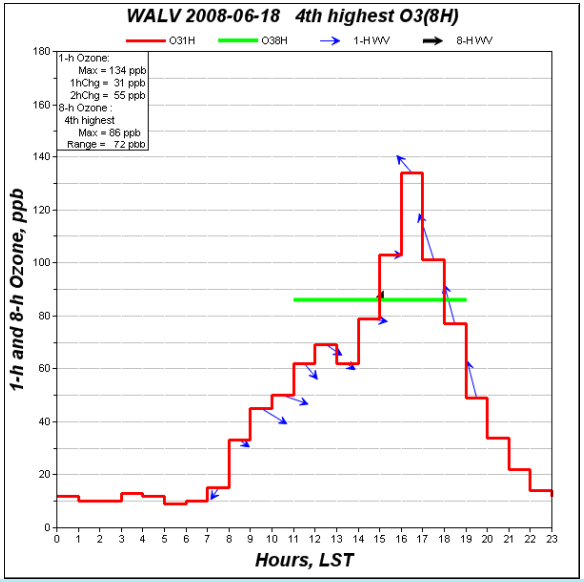
Meeting Houston's Ozone Challenges

- Address the factors that make **Houston's ozone unique** (i.e., dual-ozone)

Typical



Non-Typical



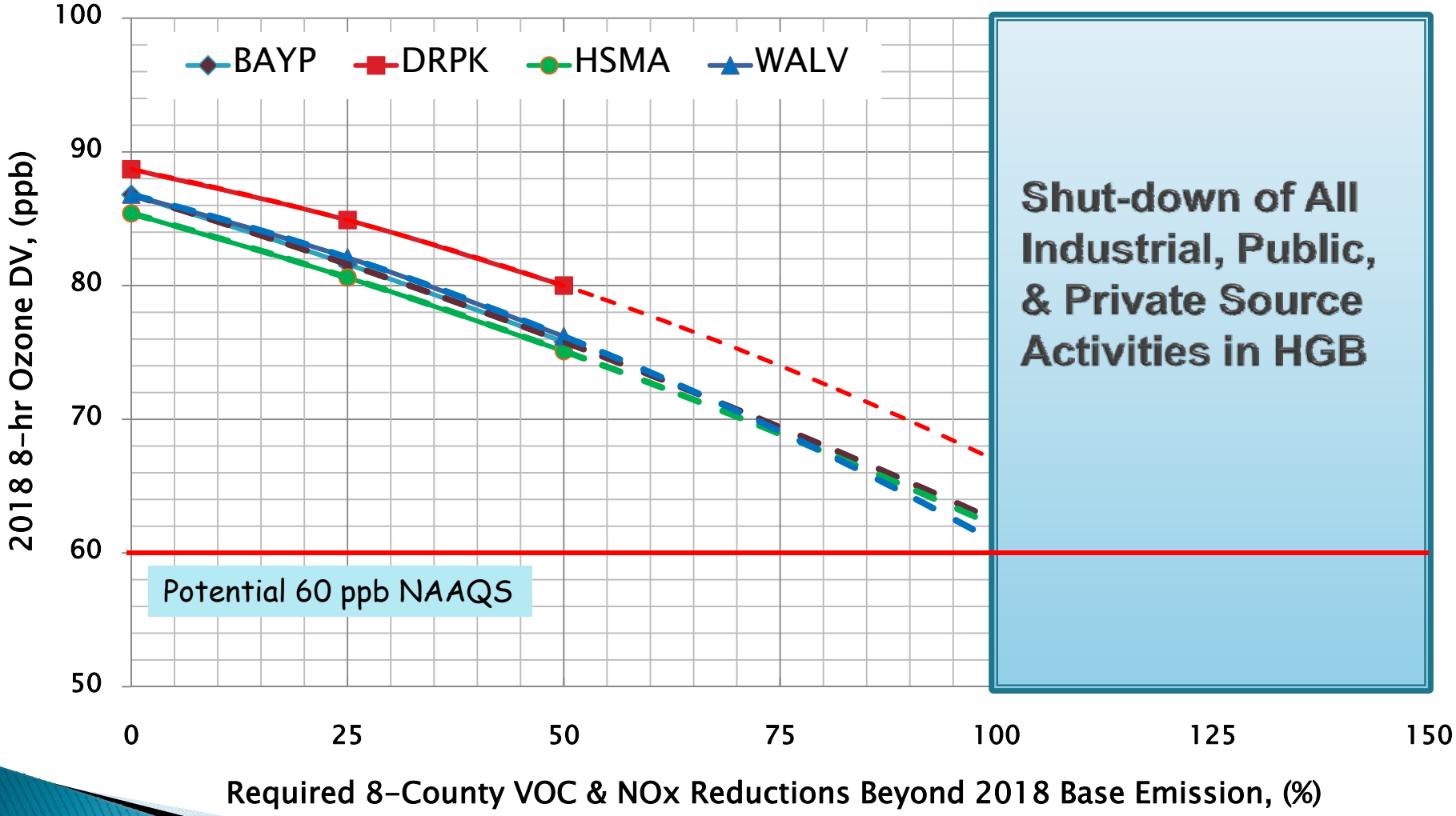
Emissions creating NTOCs not in model

- Utilize newly developed modeling tools, high performance computing, inventorying techniques, and model application methods.

- Leverage expertise and resources of other researchers in Texas and U.S

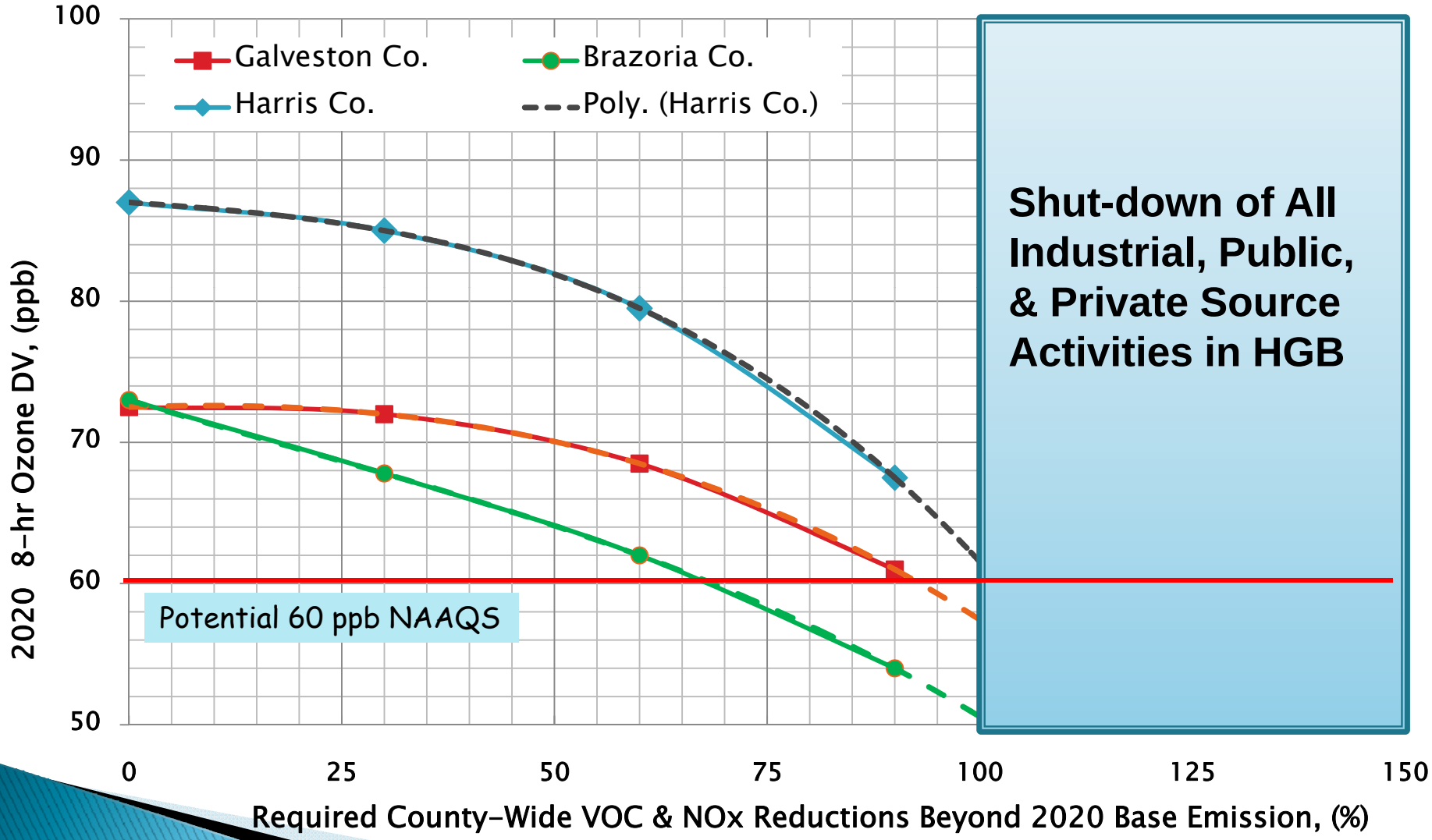
Since ozone SIPs take 3+ years to develop, *we must begin now!*

Attainment of Lower 8-hr NAAQS Virtually Impossible if EPA's Default Modeling Guidance is Followed in HGB



Data Points From 2010 HGB SIP (Figure 3-49)

Independent EPA Modeling of HGB for 2020 Also Shows Nearly Impossible Control Requirements in HGB



Data From EPA 8-hr Ozone RIA (Mar '08, Figure 4.2a)

Dual-Ozone Control Paradigm

- Discovery of Houston's unique THEOs & NTOC ozone forming phenomena is the most significant finding in 30 yrs.

- EPA-approved TCEQ 2004 SIP demonstrated that
  - The Houston region has 'typical' or 'routine' emissions like any large city, relatively steady and repeatable day-to-day. Included in modeling inventory.

  - The Houston region also has short-term HRVOC 'releases' or 'events', which are essentially random in magnitude and place. Not included in modeling inventory!

- TCEQ's 2004 HGB SIP established a highly-effective dual-ozone management approach
  - 'Routine' HRVOC emissions controlled by enforceable annual cap and trade program.
  - 'Random' HRVOC emissions controlled by a short-term limit of 1200 lb/hr.

- Under TCEQ's dual-ozone control paradigm, 8-hr ozone exceedances and days exhibiting THEO & NTOC phenomena have plummeted since 2005.

‘Ensemble/Direct Attainment Modeling’ Program

- Define new multiscale modeling domains (36/12/4/2) centered over HGB
- Develop new ozone season modeling episodes for 2008, 2009 & 2010 (2011 if necessary and possible).
- Assemble multiple configurations (ensembles) from state-of-science meteorological (MM5, WRF), chemical transport (CAMx, CMAQ, WRF-Chem) and chemical mechanism (CB05, SAPRC07, RADM2) modeling tools.
- Test and refine ensemble model configurations with TCEQ’s 2006 SIP episodes.

Ensemble/Direct Attainment (continued)

- Construct model-ready EI's for 2008, 2009, 2010 using SMOKE.
- Evaluate each ensemble configuration's performance for 2008, 2009 & 2010 (2011) ozone seasons.
- Develop bias-correction procedures for use in direct attainment estimation.
- Construct model-ready EI's for 2020, 2021, 2022 or later period depending upon HGB's attainment date under new NAAQS.

Ensemble/Direct Attainment (concluded)

- **Directly simulate** future year ozone seasons and estimate NAAQS attainment using the 4th highest MDA8 ozone concentration by monitor for the three contiguous future year periods.

- Using selected multiscale ensemble configurations, estimate future control requirements, focusing more on local and upwind area-specific VOC & NOx reductions than across-the-board changes.

- Express the future attainment results in probabilistic terms to provide additional information for decision-makers.

- Compare and assess the attainment results and technical justifications of the 8-hr Coalition's Ensemble/Direct Attainment weight-of-evidence modeling and the modeling developed by the TCEQ for the 2013 SIP.

Multiscale Ensemble Modeling

- Use of just one model (CAMx) for Houston (adopted by TNRCC in 1999) should be re-considered in view of science developments over the past 12 years.
- Multiple, state-of-science modeling tools offer far more robust and corroborative information compared to the data from any one model.
- In Houston, use of eight ensemble models with the 2006 TexAQS II data base has already been successfully demonstrated (McKeen et al., 2009).
- Not all ensemble models need to be operated by TCEQ scientists on in-house computers, but agency staff will need to coordinate the modeling exercises and lead development of Houston-specific technical findings and policy approaches.

Direct O_3 Attainment Estimation

- Current state-of-science models, satellite data bases and high-performance computers allow direct comparison of future ozone concentrations with the exact form of the NAAQS.

- These modern resources eliminate the need for the simplified approximations underlying EPA's national modeling guidance.

- Direct use of multiscale, ensemble models -- with bias-correction and uncertainty estimates – will allow HGB decision-makers to describe, for the first time, the various contributors (e.g., international sources, upwind states, upwind Texas communities, biogenic emissions, source activity over the Gulf) to future ozone attainment prospects at individual monitoring locations.

- Recasting the ozone modeling results into a probabilistic framework to extend the utility of the results for public policy-makers.

Summary

- Recent modeling with EPA's one-ozone paradigm reveals nearly impossible HGB control requirements on all sources under any lower NAAQS.

- When compared to the dual-ozone formation paradigm, the EPA RRF method generates modeled DV_F's much as 11 ppb higher at key monitors for the 2005/2006 SIP episodes.

- The 8-hr Coalition's science program over the next 3-4 years is designed to integrate:
  - Multiple state-of-science modeling tools covering all spatial scales of relevance to Houston.
  - High Performance Computing.
  - Innovative ensemble and probabilistic modeling methods.
  - Direct numerical simulation of future 8-hr ozone levels for comparison to the lower NAAQS.

- The results of the Coalition's modeling efforts will be compared with the TCEQ's 2013 SIP modeling work when both are completed so that the strongest weight-of-evidence support for the SIP is obtained.