IMPLEMENTATION OF WARM-MIX ASPHALT (WMA) GREEN TECHNOLOGIES IN PUERTO RICO – A PRHTA'S PERSPECTIVE

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Symposium: From Theory to Practical Implementation of Warm Mix Asphalt in Puerto Rico

FHWA'S Every Day Counts Initiative

- EDC is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of our roadways, and protecting the environment.
- Accelerating Technology Deployment:
  - Adaptive Signal Controls
  - Prefabricated Bridges
  - Geosynthetic Reinforced Soil
  - Safety Edge
  - **Warm-Mix Asphalt (WMA)**

WHAT IS WMA?

- Generic term for a variety of technologies that allow the production of Hot Mix Asphalt (HMA) at lower temperatures without sacrificing performance.

- Produced at temperatures approximately 50 °F (28 °C) or more cooler than HMA.

Benefits of WMA

- Reduced emissions;
- Reduced fuel and energy use (20-35%)[1]
- Reduce paving costs;
- Improve asphalt mix compaction;
- Allow asphalt mix to be hauled longer distances;
- Improve working conditions by reducing exposure to fuel emissions, fumes and odors;
- Allow for the inclusion of a greater amount of Reclaimed Asphalt Pavement (RAP) in asphalt mixtures.

[1]**Reference National Center for Asphalt Technology (NCAT)**

Other Potential Benefits of WMA

- Less binder oxidation during production combined with better in-place densities should lead to better durability.

Available WMA Technologies

- Chemical additives
  - Evotherm
  - Evotherm DAT
  - REVIX
  - Rediset WMX
  - Cecabasa RT
- Organic additives
  - Sasobit

Available WMA Technologies

- Mechanical foaming technologies
  - Double Barrel Green
  - Terex Warm Mix Asphalt System
  - Gencor
  - Stansteel
- Foaming additives
  - LEA
  - Aspha-min
  - Advera WMA
  - WAM Foam

History of WMA

- 1995-96 - First European experiments
- 1997-99 – First pavements constructed in Europe
- 2002 - NAPA Study Tour to Europe
- 2003 - Featured at NAPA's Annual Convention
- 2004
  - Demonstration at World of Asphalt
  - First U.S. field trials (Aspha-min) in FL and NC
- 2005-06
  - Numerous field trial, some "production" paving in MO
  - NCAT publishes research on several WMA technologies.

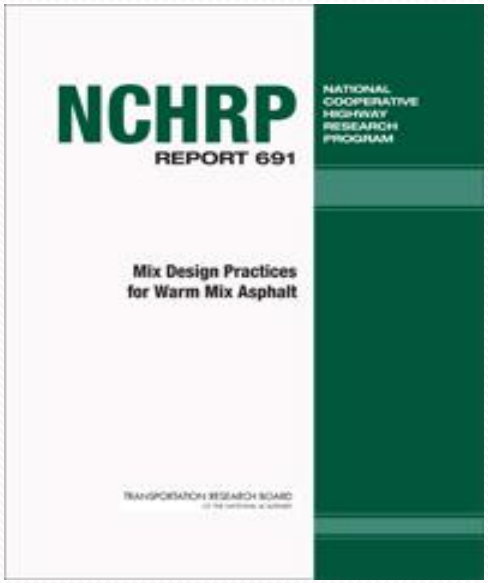
History of WMA

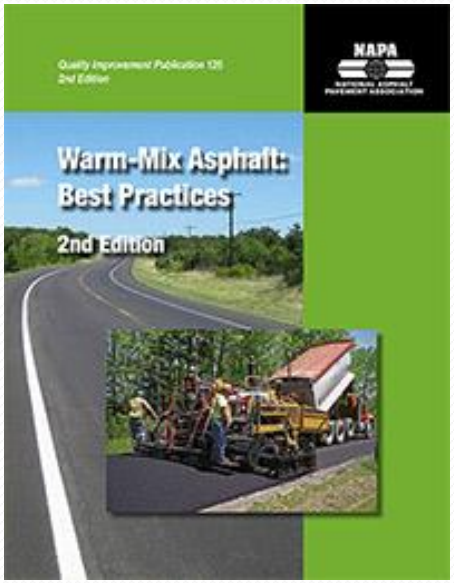
- 2007
  - FHWA Scan tour
  - AASHTO/NCHRP research projects initiated
- 2008
  - Documented WMA trials in 32 States to date.
- 2010
  - Documented WMA trials in 45 States and 10 Canadian provinces to date.
- 2011
  - NCHRP Project 9-43 completed – NCHRP Report 691 – AASHTO R35 Draft Appendix

Pertinent Technical Documents Related to WMA

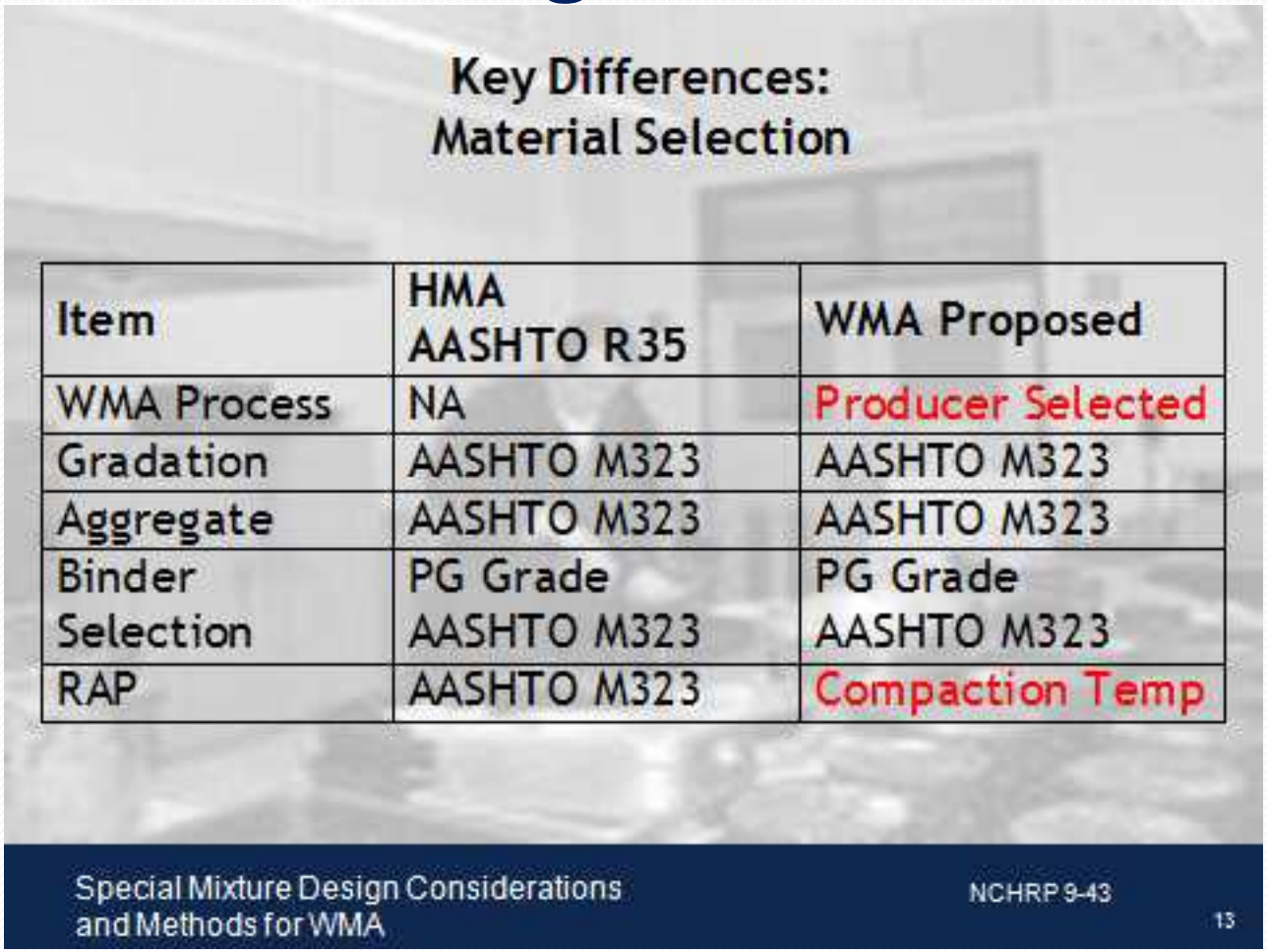
- Mix Design Practices for Warm Mix Asphalt – NCHRP Report 691, 2011 – AASHTO R 35 Draft Appendix – Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA) .

- Warm Mix Asphalt: Best Practices (2nd edition) – National Asphalt Pavement Association (NAPA) (QIP 125) – 2011.





Key Differences HMA vs. WMA – Design Process



Reference: NCHRP 9-43 – R. Bonaquist

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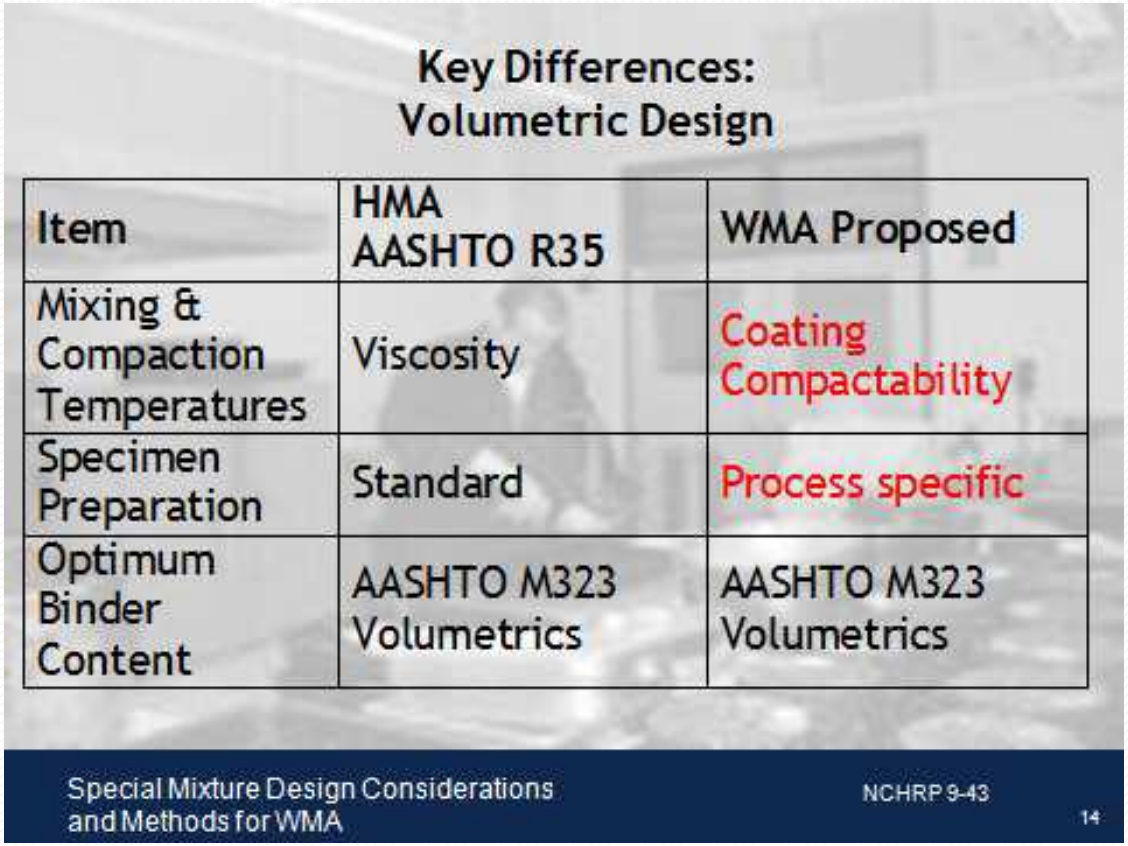

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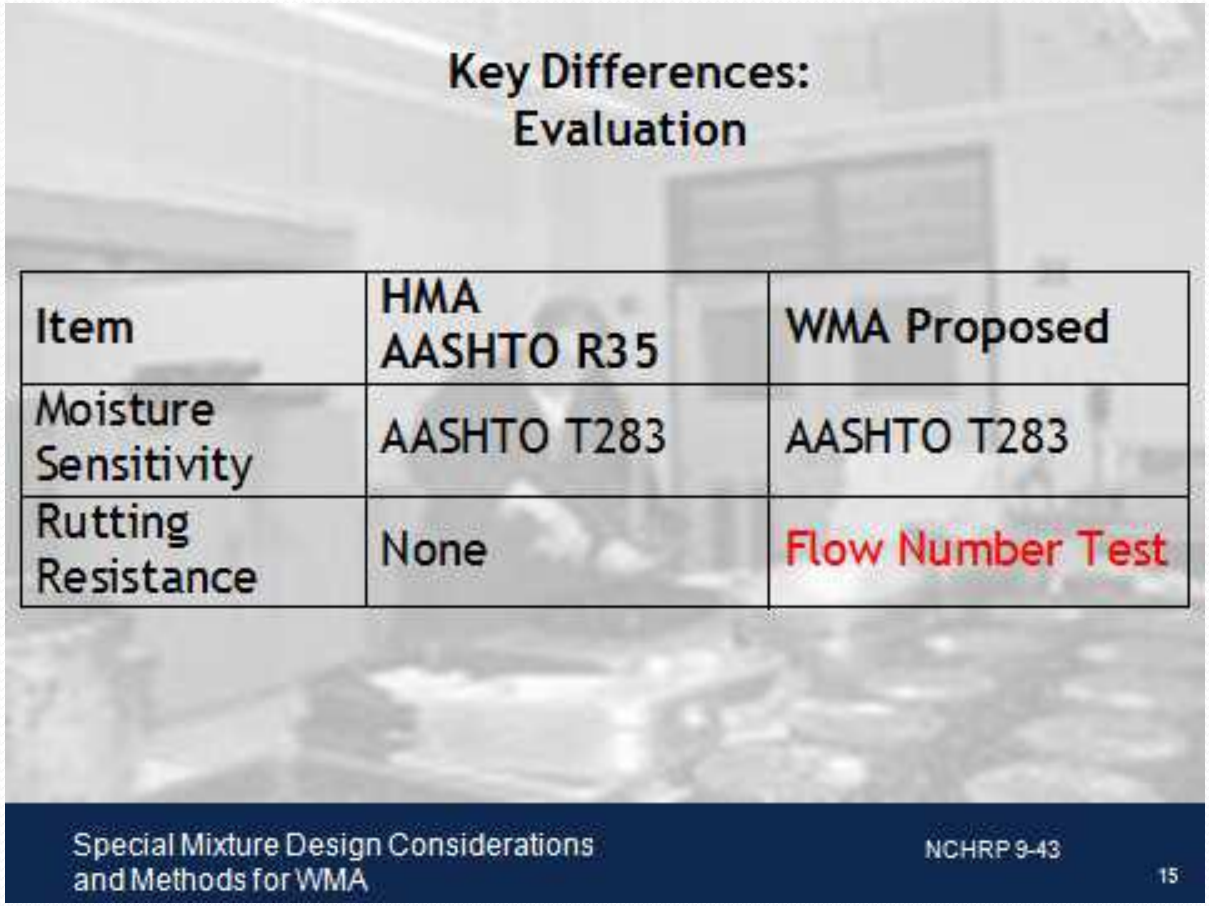

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Coating

- Prepare loose mix at optimum binder content per specimen fabrication procedures
  - Mixing times in Appendix to AASHTO R-35 are for planetary mixers
- Evaluate coating per AASHTO T195
  - Separate coarse aggregates
    - 9.5 mm sieve for NMAS 12.5 mm and larger
    - 4.75 mm sieve for NMAS 9.5 and smaller
    - Min 200 particles
  - $\%\ Coated\ Particles = \left(\frac{\#\ of\ Fully\ Coated\ Particles}{Total\ \#\ of\ Particles}\right) x100\%$
- >= 95 percent

Special Mixture Design Considerations and Methods for WMA NCHRP 9-43 23

Reference: NCHRP 9-43, R. Bonaquist

Compactability

- Prepare mix for 4 gyratory specimens and one maximum specific gravity specimens at the optimum binder content
- Compact 2 specimens to N_{design} at the planned compaction temperature
  - Compute gyrations to 92 % of Gmm
- Compact 2 specimens to N_{design} at 30 °C below the planned compaction temperature
  - Compute gyrations to 92 % of Gmm
- $Ratio = \frac{(N_{92})_{T-30}}{(N_{92})_T}$ <= 1.25

Special Mixture Design Considerations and Methods for WMA NCHRP 9-43 24

Reference: NCHRP 9-43, R. Bonaquist

Moisture Sensitivity and Rutting Resistance

- AASHTO T283
  - Tensile strength ratio >= 0.80 with no visual stripping
- Rutting resistance
  - Flow number, AASHTO T79

Traffic Level, Million ESALs	Minimum Flow Number
<3	NA
3 to < 10	30
10 to < 30	105
≥ 30	415

Special Mixture Design Considerations and Methods for WMA

NCHRP 9-43

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PRHTA Implementation Strategies

- Initial presentation of WMA technology to local Asphalt Contractors (Industry).
- Construction of small WMA test sections in existing PRHTA projects.
- Workshop on WMA technologies to Industry.
- Develop WMA specifications (For Both Marshall and Superpave Mixes).
- Modify current contract documents of projects to use WMA in lieu of HMA.
- Perform peer exchanges with several states that have successfully used WMA, such as Florida and Georgia.
- Let pilot projects using WMA.

Tasks Performed

- Initial presentation of WMA technologies:
  - February 21-25, 2011 – Assistance provided by FHWA and the National Center for Asphalt Technology (NCAT).
- WMA test section:
  - Project AC-200240, PR-2,Yauco, Production Date: April 8, 2011, SPS Mix - To be presented by BAC.
- WMA and GTR workshop:
  - April 12-13, 2011 – Presenters included Mr. Mathew Corrigan (FHWA), Dr. Randy West (NCAT) and Dr. Brian D. Prowell (Advanced Materials Services, LLC) – **The Who is Who in WMA**.

Tasks Performed

- WMA specification development:
  - Special Provision 962 (Marshall) and 964 (Superpave) - Latest Revision performed on 9/11/11. Specifications revised by FHWA and NCAT.
  - Developed using WMA Guide Specification for Highway Construction – WMA Technical Working Group as well as NCHRP report 691.
  - WMA will be alternate bid pay items for HMA (HMA vs. WMA head to head).
  - HMA volumetric properties shall still be met at the WMA compaction temperature.
  - Drop on additive process is acceptable provided met requirements. This process will must certainly expedite WMA designs and, therefore, implementation of WMA in PRHTA projects.

Tasks Performed

- WMA specification development (cont.):
  - Performance Testing required for acceptance:
    - Moisture Susceptibility - AASHTO T-283 (Dry Strength and Tensile Strength Ratio – TSR)
    - Rutting Resistance - Flow Number (Fn) - AASHTO TP-79 – Asphalt Mixture Performance Tester.
  - Performance test required for information:
    - Dynamic Modulus (E*) – AASHTO TP-79 – Mix Stiffness - Master curve and coefficients also used in MEPDG.
    - Rutting Resistance and Moisture Susceptibility – AASHTO T-324 (Number of passes to produce a specific rut depth and number of passes to stripping inflection point).

Tasks Performed

- Pre-Approved List of WMA Technologies (PRHTA W401-10)
  - Chemical and Organic Additives – Selected due to immediate implementation and "drop on" capabilities.
  - Most Common additives included in DOT's approved Lists.

WMA Technology	Process Type	WMA Supplier
Evotherm™ DAT	Chemical Additive	MeadWestvaco
Evotherm™ 3G	Chemical Additive	MeadWestvaco
Rediset™ WMX	Chemical Additive	Akzo Nobel Surfactants
Sasobit®	Organic Additive	Sasol Wax Americas

Tasks to be Performed

- Modifying current HMA projects:
  - WMA will be used on projects AC-520108 and AC-520109 – South Region (approximately 40,000 tons).
- Continue monitoring performance of WMA test section as well as control HMA.
- Peer exchange/review (scan tours to Florida and Georgia with Industry).
- Let pilot projects using WMA.

EDC Performance Measures for WMA

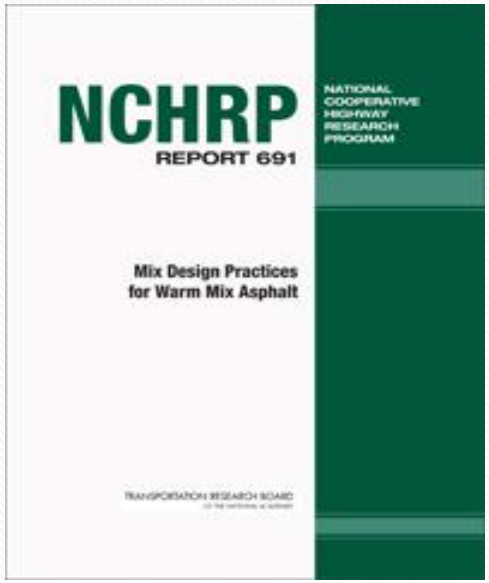
- By December 2011, 40 State DOTs and all Federal Land Divisions will have a specification and/or contractual language that allow Warm Mix Asphalt on Federal-Aid or Federal Lands projects.
- PRHTA has already met the initial performance measure (WMA specifications for both Marshall and Superpave Mixes).

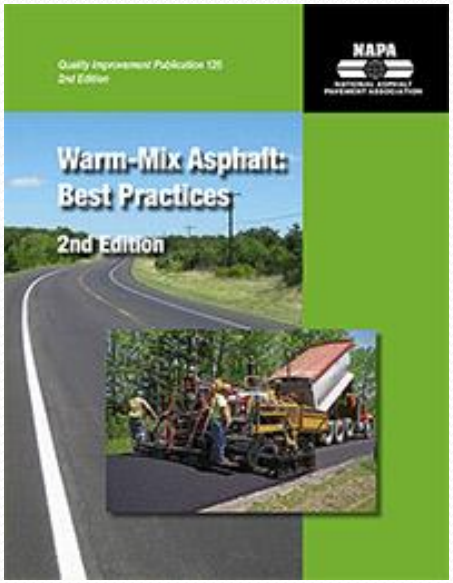
References

http://www.fhwa.dot.gov

http://www.fhwa.dot.gov/everydaycounts/

warmmixasphalt.com





Related on going Initiatives

- Transportation Pooled Fund Programs:
  - TPF-5(178) - Implementation of the Asphalt Mixture Performance Tester (AMPT) for Superpave Validation - NCAT.
    - Acquisition of Laboratory Equipment
    - Training (Engineers and Technicians)
    - Round Robin Program
  - TPF-5(228) Superpave Regional Center, Southeastern Region - NCAT
    - Technician Training and Certification Program (TTCP)
    - Technical Assistance
    - Forensic Testing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Challenges Faced by Industry and PRHTA

- Continue to build on initial WMA successful implementation **(from theory to practice)**.

- Continue to build on considerable improvements in asphalt pavement quality started in 2009 through revisions of contract documents and procedures (Contractor's Quality Control Plans, Test Sections, Pre-paving meetings, PWL, AASHTO T-283 optimization procedure, etc.). This effort also included improvements in drainage considerations in new and rehabilitated pavements.

- Continue improving rutting resistance and moisture susceptibility of our asphalt mixes (HMA and WMA).
  - Include requirements of AASHTO T-324 for acceptance of Mix Designs (JMF).

Challenges Faced by Industry and PRHTA

- Implementation of Mechanistical-Empirical Pavement Design Guide (MEPDG):
  - Develop Catalog of Puerto Rico Materials.
  - Life Cycle Cost Analysis for Pavement and Rehabilitation selection.
- Aggregate cleanliness and its effects on quality and performance:
  - Interdisciplinary group should be established to address concerns of all parties involved in the process (Industry, Local Government, Academia, Federal Government, etc.)
  - As an initial step to the above, research efforts has started or will be started in the near future to quantify the effect of aggregates cleanliness in pavement performance through testing (NCAT).

THANK YOU!