A Practice for Including Intelligent Construction Equipment in a Quality Assurance Program

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Acronyms and Abbreviations

AA = Agency acceptance
AASHTO = American Association of State Highway and Transportation Officials
AQC = Acceptance quality characteristic
CFR = Code of Federal Regulations
DDIAPT = Development and deployment of innovative asphalt pavement technologies
DPS = Dielectric profiling system
DR = Dispute resolution
GPS = Global positioning system
IA = Independent assurance
IC = Intelligent compaction
ICE = Intelligent construction equipment
IR = Infrared
LA/Q = Laboratory accreditation / qualification
NDT = Non-destructive technologies
PMTP = Paver-mounted thermal profilers
PQ/C = Personnel qualification / certification
QA = Quality assurance
QC = Quality control
UNR = University Nevada Reno

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Overview of DDIAPT

Development and Deployment of Innovative Asphalt Pavement Technologies (DDIAPT)

- A Cooperative effort between FHWA and the University of Nevada at Reno.

Objective:

- Stimulate, facilitate, and expedite the deployment and rapid adoption of new and innovative technology relating to the design, production, testing, control, construction, and investigation of asphalt pavements.

Core Project Team:

- University of Nevada at Reno
- Paragon Technical Services
- Applied Research Associates, Inc.

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Presentation Outline

1. Intelligent Construction Equipment Report
2. Other Products Discussing NDT Technologies
3. Takeaways/Conclusions

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ICE Technical Report

FHWA Technical Report
FHWA-HIF-23-007
January 2023

https://www.fhwa.dot.gov/pavement/asphalt/HIF_Intelligent_Construction_Equipment_QA.pdf

Authors: Harold Von Quintus, Hadi Nabizadeh, Adam Hand, and Elie Hajj

Objective:

- Provide information for including ICE in a QA program conforming to 23 CFR 637 Subpart B.


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ICE Technical Report

1. Intelligent Compaction – QC
2. Dielectric Profiling System – QC or Acceptance
3. Paver Mounted Thermal Profiler – QC or Process Control



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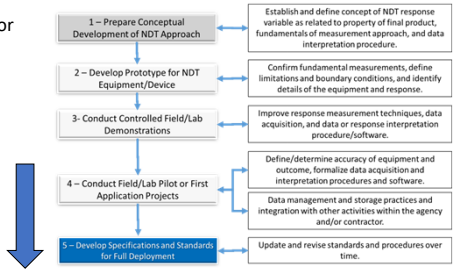
ICE Technical Report

Five optional stages for deploying innovative technologies.



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ICE Technical Report

QA Core Elements:

1. Agency acceptance
2. Contractor quality control
3. Independent assurance
4. Dispute resolution
5. Qualified laboratories
6. Qualified testing/sampling personnel

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ICE Technical Report

Quality Control:

- Activities of the contractor required by the agency.

Process Control:

- Voluntary activities of the contractor; not required by the agency.

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Asphalt Pavements – Contractor Testing (2022)

States that used contractor test results in the acceptance decision for asphalt pavements.

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Intelligent Compaction

AASHTO R 111-22

- Monitors roller passes (level 1).
- Estimates the stiffness (level 2).
- Response feedback to adjust roller energy (level 3).


Coverage uniformity of breakdown rolling pattern.

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Intelligent Compaction

Technical Issues / Challenges

- Monitoring roller passes (level 1) ready for QC.
- Still considered to be in implementation stage 3 (levels 2 and 3).
  - Impact of mat temperature & cooling rate?
  - Impact of supporting layer/foundation?

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Intelligent Compaction

QA Potential

1. Quality Control / Process Control
   a. Confirm rolling pattern results in obtaining a uniform mat density (level 1).

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Paver Mounted Thermal Profiler

- IR Scanner and GPS attached to paver on a mast or post.
  - IR Scanner measures mat temperature behind screed.
  - GPS used for location.

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Paver Mounted Thermal Profiler

AASHTO R 110-22

- Estimates surface temperatures of asphalt mat behind the paver.
- Excessive temperature differentials across the mat typically results in excessive variability in mat density.

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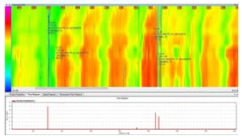
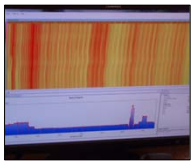
Paver Mounted Thermal Profiler

IR Scanner screen used to "see" and monitor mat temperatures in real time.

Outcomes:

- Measures surface temperatures.
- Time diagram screen; number of stops.
- Paver speed diagram screen.





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Paver Mounted Thermal Profiler

QA Potential

- Quality Control / Process Control

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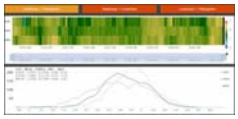
Dielectric Profiling System

AASHTO PP 98-19

- Measures the average dielectric constant/value of the asphalt mat, which can be correlated to mat density.
- Evaluates entire asphalt mat; assumption of a normal distribution not needed.
- Percent conforming between the minimum and maximum limits of AQC.
- Longitudinal profiles measured.



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Dielectric Profiling System

Challenges

- Dielectric value correlated to density/air void, dependent on different variables:
  - Surface condition; dry, damp, wet.
  - Mat thickness.
  - Bulk specific gravity/air void gradient.
- Field-derived relationship using only cores.
  - Lab-compacted may have advantages.
- Operator safety and fatigue.
- Weather / moisture.
- GPS connectivity.
- Data management.

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Dielectric Profiling System

QA Potential

1. Acceptance with agency testing.
   a. Agency or designated agent.
2. Quality Control / Process Control.
   a. Confirm uniformity of mat density.

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Dielectric Profiling System

QA Issues / Challenges

Especially when used for acceptance & pay determination

1. Acceptance with contractor testing.
   a. Agency verification.
   b. Validation of contractor results.
2. Independent assurance.
   a. Contractor's equipment and personnel.
3. Training and certification of construction personnel/paver operator.
   a. Equipment to undergo annual certification.
   b. Equipment should be verified at beginning of the project.
   c. Calibrate GPR sensors each day of use.
   d. Personnel trained in setting up and using the DPS.
4. Dispute resolution.
   a. Cores?
5. Precision and bias of the AQC – dielectric value (density).
   a. Tolerance and threshold values needed.

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Other Selected Products Using NDT in QA

TPF-5(443): Continuous Asphalt Mixture Compaction Assessment using Density Profiling System (DPS)

- https://www.pooledfund.org/Details/Study/667

FHWA Workshop: Quality in the Asphalt Paving Process.

- https://www.fhwa.dot.gov/pavement/asphalt/trailer/MATC_workshop_flyer.pdf

FHWA Spotlight on Pavement Density and Uniformity

- https://www.fhwa.dot.gov/pavement/asphalt/trailer/construction.cfm

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Takeaways/Conclusions

1. IC, PMTP, and DPS represent opportunities to:
   a. Impact asphalt pavement performance positively.
   b. Provide spatial quality information.
2. Remember the role of the Quality Assurance Program.

ICE	Acceptance	Quality Control / Process Control
IC		Yes
PMTP		Yes
DPS	Yes with Agency testing	Yes

3. Management of real-time, continuous data with map-based viewing (e.g., Veta) is a tool for agencies and contractors to assess the uniformity of placement and compaction processes to achieve quality.

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Thank you

Questions/Discussion?

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