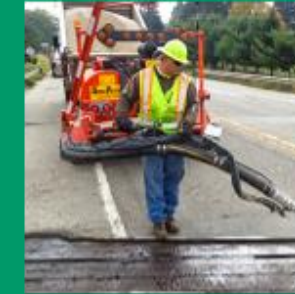


# ODOT OFFICE OF GEOTECHNICAL ENGINEERING

## EXPLORATION AND LAB UPDATES



OHIO DEPARTMENT OF  
TRANSPORTATION

P. Paul Painter

## ODOT White Paper: Comparison of Energy Transfer Ratios from Automatic Hammer Systems for Split Spoon Testing

Automatic hammers are required to be used and calibrated to determine the Energy Transfer Ratio (ETR or ER) values every two years per ODOT Specifications for Geotechnical Explorations (SGE) Section 402.2.

OGE has seen wide variations within the reported Energy Transfer Ratio (ETR or ER) values, including some values over 100%.

Consultants: A total of 24 firms are listed as being prequalified firms to complete Geotechnical Field Exploration services. A total of 16 firms, or 67%, responded to the questionnaire.

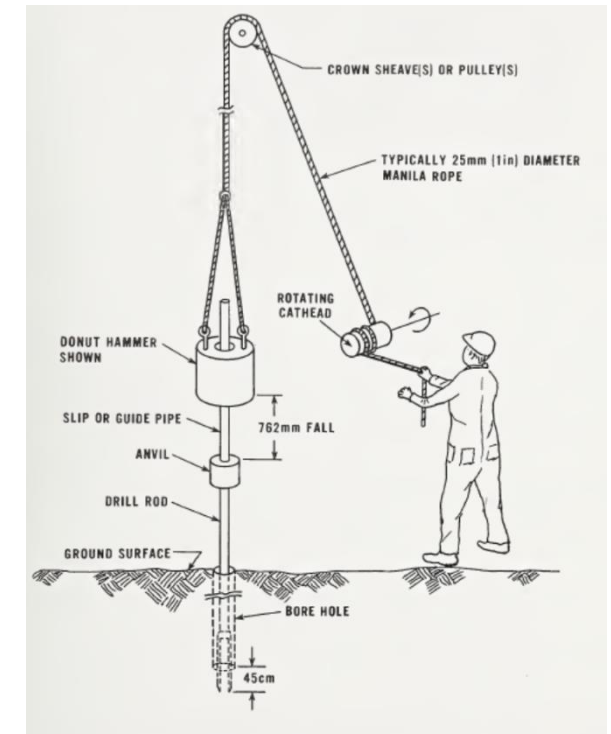
Manufacturers': As part of this study, we presented a questionnaire to the manufacturers of the drills being used on ODOT projects, except for BG. All six manufacturers responded.

# ENERGY TRANSFER RATIOS WHITE PAPER

## Why is it important?

SPT data is one of the mostly widely utilized tools for geotechnical design. There is a long and proven history in the completion of SPT data collection. Correlations between SPT resistance and design parameters such as soil bearing capacity, elastic modulus of soils, and soil shear strength have been and continue to be widely used.

The first SPT correlations were presented by Terzaghi and Peck in 1948 in their publication *Soil Mechanics in Engineering Practice* and expanded by Peck et al. in 1953 in *Foundation Engineering*.





# NON-COHESIVE SOIL ETR SPT ADJUSTMENT

ETR	Scaler	ETR	Scaler	ETR	Scaler	ETR	Scaler	ETR	Scaler	ETR	Scaler	ETR	Scaler	ETR	Scaler	ETR	Scaler	ETR	Scaler
55	0.92	60	1.00	65	1.08	70	1.17	75	1.25	80	1.33	85	1.42	90	1.50	95	1.58	100	1.67
1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	1	2	2
2	2	2	2	2	2	2	2	2	3	2	3	2	3	2	3	2	3	2	3
3	3	3	3	3	3	3	4	3	4	3	4	3	4	2	5	3	5	3	5
4	4	4	4	4	4	4	5	4	5	4	5	4	6	4	6	4	6	4	7
5	5	5	5	5	5	5	6	5	6	5	7	5	7	5	8	5	8	5	8
6	6	6	6	6	7	6	7	6	8	6	8	6	9	6	9	6	10	6	10
7	6	7	7	7	8	7	8	7	9	7	9	7	10	7	11	7	11	7	12
8	7	8	8	8	9	8	9	8	10	8	11	8	11	8	12	8	13	8	13
9	8	9	9	9	10	9	11	9	11	9	12	9	13	9	14	9	14	9	15
10	9	10	10	10	11	10	12	10	13	10	13	10	14	10	15	10	16	10	17
11	10	11	11	11	12	11	13	11	14	11	15	11	16	11	17	11	17	11	18
12	11	12	12	12	13	12	14	12	15	12	16	12	17	12	18	12	19	12	20
13	12	13	13	13	14	13	15	13	16	13	17	13	18	13	20	13	21	13	22
14	13	14	14	14	15	14	16	14	18	14	19	14	20	14	21	14	22	14	23
15	14	15	15	15	16	15	18	15	19	15	20	15	21	15	23	15	24	15	25
16	15	16	16	16	17	16	19	16	20	16	21	16	23	16	24	16	25	16	27
17	16	17	17	17	18	17	20	17	21	17	23	17	24	17	26	17	27	17	28
18	17	18	18	18	20	18	21	18	23	18	24	18	26	18	27	18	29	18	30
19	17	19	19	19	21	19	22	19	24	19	25	19	27	19	29	19	30	19	32
20	18	20	20	20	22	20	23	20	25	20	27	20	28	20	30	20	32	20	33
21	19	21	21	21	23	21	25	21	26	21	28	21	30	21	32	21	33	21	35
22	20	22	22	22	24	22	26	22	28	22	29	22	31	22	33	22	35	22	37
23	21	23	23	23	25	23	27	23	29	23	31	23	33	23	35	23	36	23	38
24	22	24	24	24	26	24	28	24	30	24	32	24	34	24	36	24	38	24	40
25	23	25	25	25	27	25	29	25	31	25	33	25	35	25	38	25	40	25	42
26	24	26	26	26	28	26	30	26	33	26	35	26	37	26	39	26	41	26	43
27	25	27	27	27	29	27	32	27	34	27	36	27	38	27	41	27	43	27	45
28	26	28	28	28	30	28	33	28	35	28	37	28	40	28	42	28	44	28	47
29	27	29	29	29	31	29	34	29	36	29	39	29	41	29	44	29	46	29	48
30	28	30	30	30	33	30	35	30	38	30	40	30	43	30	45	30	48	30	50
31	28	31	31	31	34	31	36	31	39	31	41	31	44	31	47	31	49	31	52
32	29	32	32	32	35	32	37	32	40	32	43	32	45	32	48	32	51	32	53
33	30	33	33	33	36	33	39	33	41	33	44	33	47	33	50	33	52	33	55
34	31	34	34	34	37	34	40	34	43	34	45	34	48	34	51	34	54	34	57
35	32	35	35	35	38	35	41	35	44	35	47	35	50	35	53	35	55	35	58
36	33	36	36	36	39	36	42	36	45	36	48	36	51	36	54	36	57	36	60
37	34	37	37	37	40	37	43	37	46	37	49	37	52	37	56	37	59	37	62
38	35	38	38	38	41	38	44	38	48	38	51	38	54	38	57	38	60	38	63
39	36	39	39	39	42	39	46	39	49	39	52	39	55	39	59	39	62	39	65
40	37	40	40	40	43	40	47	40	50	40	53	40	57	40	60	40	63	40	67
41	38	41	41	41	44	41	48	41	51	41	55	41	58	41	62	41	65	41	68
42	39	42	42	42	46	42	49	42	53	42	56	42	60	42	63	42	67	42	70
43	39	43	43	43	47	43	50	43	54	43	57	43	61	43	65	43	68	43	72
44	40	44	44	44	48	44	51	44	55	44	59	44	62	44	66	44	70	44	73
45	41	45	45	45	49	45	53	45	56	45	60	45	64	45	68	45	71	45	75
46	42	46	46	46	50	46	54	46	58	46	61	46	65	46	69	46	73	46	77
47	43	47	47	47	51	47	55	47	59	47	63	47	67	47	71	47	74	47	78
48	44	48	48	48	52	48	56	48	60	48	64	48	68	48	72	48	76	48	80
49	45	49	49	49	53	49	57	49	61	49	65	49	69	49	74	49	78	49	82
50	46	50	50	50	54	50	58	50	63	50	67	50	71	50	75	50	79	50	83
51	47	51	51	51	55	51	60	51	64	51	68	51	72	51	77	51	81	51	85
52	48	52	52	52	56	52	61	52	65	52	69	52	74	52	78	52	82	52	87
53	49	53	53	53	57	53	62	53	66	53	71	53	75	53	80	53	84	53	88
54	50	54	54	54	59	54	63	54	68	54	72	54	77	54	81	54	86	54	90
55	50	55	55	55	60	55	64	55	69	55	73	55	78	55	83	55	87	55	92

Consistency Description	Standard Penetration: Blows per Foot N <sub>60</sub>
Very Loose	< 5
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

# ENERGY TRANSFER RATIOS WHITE PAPER

## Drill Manufactures Represented by Prequalified ODOT Firms

Drill Manufacture	# of Drills	% of Drills
CME	52	70%
Diedrich	8	11%
Mobile	6	8%
Geoprobe	4	5%
Acker	2	3%
BG	1	1%
Simco	1	1%

# ENERGY TRANSFER RATIOS WHITE PAPER

## Calibration Firms Utilized by Prequalified ODOT Firms

Calibration Firm	Percentage of Drills
GRL	71.0
CTL	18.4
Stantec	5.3
AFT	3.9
Terracon	1.4

## Drill Rod Size Utilized by Prequalified ODOT Firms

Drill Rod Size	Percentage of Firms
AW/AWJ	87.0
NW/NWJ	13.0

# ENERGY TRANSFER RATIOS WHITE PAPER

## Prequalified Geotechnical Field Exploration Services Questionnaire



**Question 8/9.** Do you utilize the same calibration area each time? Is the material in which the calibration is completed (soil types) the same each time? What soils types are the calibrations performed in?

Only three (3) respondents, two (2) consultants and ODOT, utilize the same area for calibration each time. Of these respondents one indicated calibration in silty clay (A-6a) materials, and two (2) perform calibration in mixed sandy and clayey soils. Soil types vary for those consultants who do not utilize the same calibration area each time.



# ENERGY TRANSFER RATIOS WHITE PAPER

## Manufacturers' Questionnaire

**Question #3.** Do you manufacture an automatic hammer system (AHS) for performing the standard penetration test (SPT)?

All respondents, except for Simco, manufacture their own AHS. CME manufactures an AHS for Simco.

**Question #4.** How many years have you been manufacturing an AHS?

AHS have been manufactured between 15 and 35 years.

**Question #5.** Does your AHS have variable speed control during SPT collection?

All manufacturers except Mobile have variable speed control for their AHS systems. Results are presented in Table 6.

**Question #6.** Do you provide certification for the components of the AHS (e.g. weight slug and drop distance)?

All manufacturers, except Acker, provide certification for their components, typically upon request.

**Question #7.** Do you provide an AHS calibration prior to sale of a new unit? If yes, who completes these calibrations?

None of the manufacturers provide calibration prior to sale, unless specifically requested by the customer.

**Question #8.** What is your anticipated range of energy transfer ration (ETR) values for your AHS?

Three (3) manufacturers provided hammer calibration ranges.

**Question #9.** If a user has an unusual AHS calibration (e.g. >100% energy transfer ratio)

do you provide technical support during the trouble shooting process?

All manufacturers stated that they will provide technical support for the AHS.

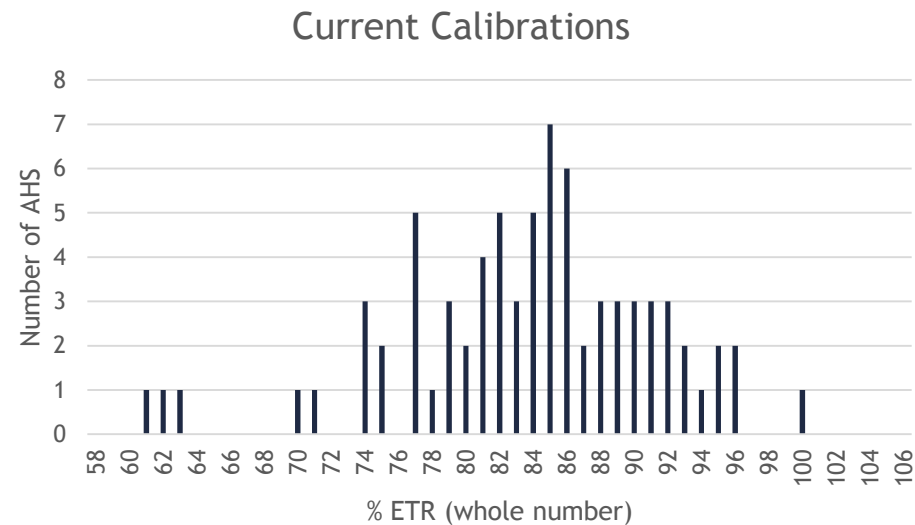
Years Manufacturer has produced AHS	
Drill Manufacturer	# of Years
CME	35
Diedrich	26
Mobile	20
Geoprobe	15
Acker	15

Anticipated ETR Range	
Drill Manufacture	ETR Range
CME	85% - 95%
Diedrich	85% - 88%
Mobile	90% - 95%*
Geoprobe	80% - 90%
Acker	**
* Based upon a single GRL calibration.	
** Per ASTM Standards	

# ENERGY TRANSFER RATIOS WHITE PAPER

## Results

A total of 76 calibration records performed within the last two years were provided for currently operating AHS drills used for geotechnical sampling on ODOT projects (Current Calibrations). The resulting ETR values range from 61% to 100% with a mean value of 83.6%. The 95% confidence interval is 81.9% to 85.3%. In Figure 3, the distribution of these current calibration ETR results, rounded to the nearest whole number, are presented, based on the corresponding number of AHS drills.

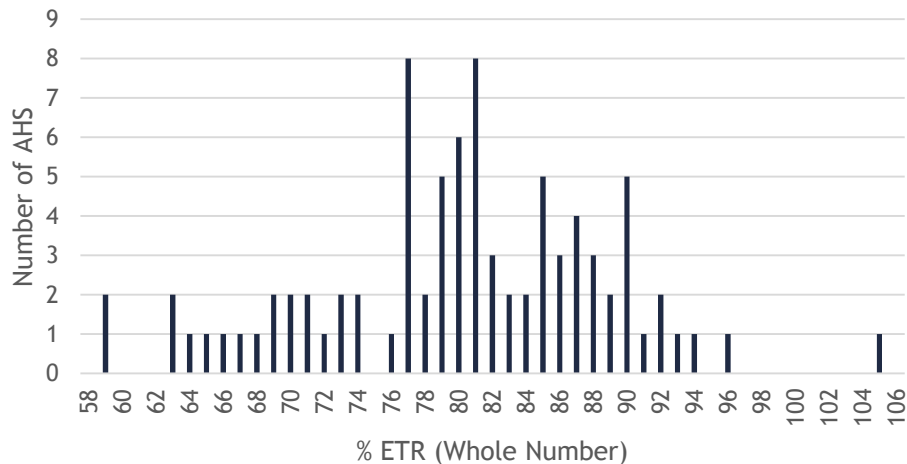


# ENERGY TRANSFER RATIOS WHITE PAPER

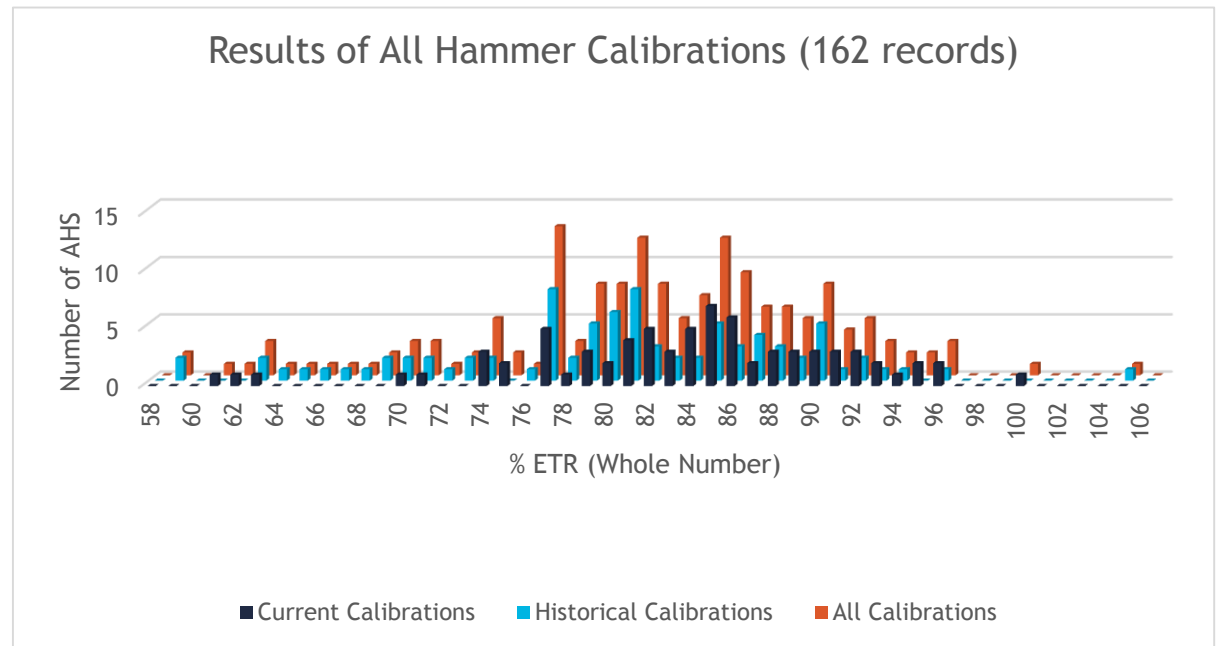
## Results

In addition to the current calibration records, 86 past calibration records (Historical Calibrations), performed more than two years ago for the currently operating AHS drills as well as retired drills, were provided for evaluation. Historical ETR values range from 59% to 105% with a mean value of 78.1%. The 95% confidence interval is 76.4% to 79.9%.

Historical Calibrations



Results of All Hammer Calibrations (162 records)



## What does it all mean?

Calibration requirements will not change.

ODOT OGE plans to restrict the ETR value used to calculate the  $N_{60}$  value to a maximum value of 90%.

## Refraction Microtremor (ReMi)

Geophysical survey method utilizing seismic surface waves (similar to SASW or MASW). Does not need an induced seismic source if a passive source (highway traffic) is present. Will generate a detailed vertical shear wave velocity ( $S_v$ ) profiles. 1-D profiles are developed and can be compiled to create a 2-D profile.

# TRAINING

## Subsurface Investigation Qualification

FHWA-NHI-132079

Min. 20 Participants

[https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=132079&course\\_no=132079&res=1](https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=132079&course_no=132079&res=1)

Offered by National Drilling Association

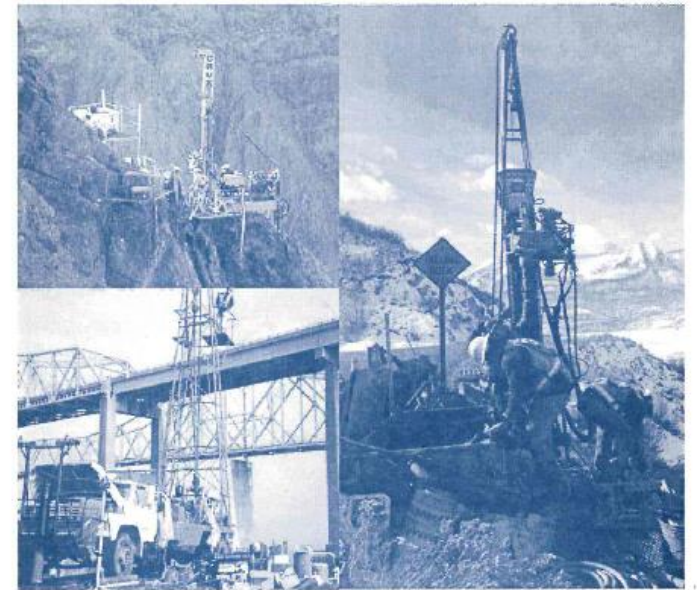
<https://nda4u.com/training/in-person-training/>

Publication No. FHWA-NHI- 05-035

NHI Course FHWA-NHI-132079

### Subsurface Investigation Qualification

Participant Workbook



# TRAINING


## Visual Classification Course for Geotechnical Logging of Soil and Rock Stratum

Ohio Department of Transportation

VISUAL CLASSIFICATION COURSE  
FOR GEOTECHNICAL LOGGING OF  
SOIL AND ROCK STRATUM

SPRING 2018

Presented by:  
Office of Geotechnical Engineering



# TRAINING

## Visual Classification Course for Geotechnical Logging of Soil and Rock Stratum

➤ Class will be offered twice per year:

Spring  
Fall

➤ Registration is through LTAP

<http://www.dot.state.oh.us/Divisions/Planning/LocalPrograms/LTAP/Pages/default.aspx>



Division of Planning  
Plan ~ Build ~ Maintain **Local Programs**

**OHIO LTAP** | Local Technical Assistance Program

### Training Course Registration

The Ohio LTAP Center provides training in the areas of highway and worker safety, infrastructure management, workforce development and organizational excellence. In addition, LTAP is your source to enroll in externally offered ODOT courses such as Environmental, Structures and Traffic Academy to name a few.

Currently LTAP traditional classroom and workshop class registrations are handled with the registration forms below.

**Training Flyers (PDFs to Download)**

<input type="checkbox"/>	Type	Name	Title	File Size
<input type="checkbox"/>	PDF	Acquisition_103_-_Part_A_-_REA_2017		195 KB
<input type="checkbox"/>	PDF	Acquisition_103_-_Part_B_-_REA_2017		183 KB
<input type="checkbox"/>	PDF	Acquisition_104_-_Instruments_2017		181 KB
<input type="checkbox"/>	PDF	Acquisition_Plan_Reading_-_REA_2017		171 KB
<input type="checkbox"/>	PDF	Asbestos_Awareness_-_REA_2017		169 KB
<input type="checkbox"/>	PDF	Bicycle_Facility_Design_-_NHI_-_2017		233 KB
<input type="checkbox"/>	PDF	Bridge_Inspection_Refreshers_Training_-_2017		128 KB
<input type="checkbox"/>	PDF	Designing_for_Pedestrian_Safety_-_NHI_2017		184 KB

- LTAP Home
- Meet the Team
- eLearning
- Webinars
- Training & Assistance
- Training Course Registration**
- Future LTAP Training
- Resources & Programs
- Smart Phone Apps
- Newsletters
- Subscribe to Mailing List
- Local Programs Home



# QUESTIONS?

