SP-151128
(New)

SPECIAL PROVISIONS
FOR
VIBRATION MONITORING

Hardin County
BRS-SWAP-0077(601)--FF-42

Effective Date
February 15, 2022

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

151128.01 DESCRIPTION.

A. This specification identifies the Contractor's responsibilities for protecting the properties listed below. The Contractor shall develop a work plan which minimizes the potential for possible vibration damage due to construction and demolition activities near the identified structures. The Contractor will also be asked to monitor vibrations and crack behavior at the identified structure(s) in order to protect them from any vibration induced damage.

B. The following properties shall be protected per the requirements in this special provision:

1. **Address.**
   1208 Water Street
   Alden, IA 50006
   Owner: Westend Enterprises, LLC

2. **Address.**
   1126 Water Street
   Alden, IA 50006
   Owner: Justin Jordahl

3. **Address.**
   1111 River Road
   Alden, IA 50006
   Owner: Gayle Poortinga

151128.02 PRECONSTRUCTION SURVEY.

A. No information is available concerning the condition of the any of these properties.

B. The Contractor shall perform a pre-construction condition survey on the previously listed properties and provide a copy of survey report(s) to the Engineer no later than 30 calendar days prior to starting work. The Contractor shall have a Professional Engineer licensed in the State of Iowa and experienced in evaluating structural vulnerabilities and vibration monitoring perform the survey.

C. The firms listed below have completed this type of vibration monitoring previously:
- Braun Intertec Corp., 5915 4th Street SW, Suite 100, Cedar Rapids, IA 52404
- Exponent, Inc., 185 Hansen Ct., Suite 100 Wood Dale, IL 60191
- Kleinfelder East, Inc., 3730 South 149th Street, Suite 107, Omaha, NE 68144
- Terracon Consultants, Inc., 600 SW 7th Street, Suite M, Des Moines, IA 50309
- Wiss, Janney, Elstner Associates, Inc., 330 Pfingsten Road, Northbrook, IL 60062

D. At a minimum the survey shall document all aspects of the structural condition through observations, actual measurements, plan sketches, photographs, and any other data the preparer may deem appropriate. The survey report shall be submitted to the Engineer electronically.

E. The Contractor shall perform a pre-construction condition survey that includes photos and plan sketches indicating existing vulnerabilities, an evaluation of the risk from construction vibration, and recommendation of maximum safe peak particle velocity (PPV) threshold. The Contractor shall determine the construction methods required to protect the properties listed above based on the pre-construction survey and the safe vibration threshold.

F. The City has obtained rights-of-entry to the properties listed above in order to engage in condition surveys, vibration monitoring, and crack monitoring.

G. The Contractor is responsible for determining if additional properties, beyond what are previously listed above, are vulnerable and require vibration monitoring. The Contractor is responsible for arranging with the additional property owner(s) the rights-of-entry to their property in order to engage in condition surveys, vibration monitoring, and crack monitoring.

151128.03 MONITORING PLAN.

A. The Contractor shall provide to the Engineer a monitoring plan no later than 14 calendar days prior to commencing work. The plan will be reviewed by the Engineer and any comments will be returned to the Contractor within 10 calendar days. The Contractor will then have 4 calendar days to revise the work plan and resubmit a final plan to the Engineer prior to commencing work.

B. The plan shall describe the following:

1. Construction methods and equipment that the Contractor chooses to use to achieve low project vibration levels.

2. Alternative construction methods and equipment that will be used if the PPV threshold is reached or exceeded.

3. Detailed description of the vibration and structural integrity monitoring systems and if necessary catalog cuts of monitoring equipment that will be used; how the equipment will be calibrated and re-calibrated if necessary during the life of the project; description and schematics if necessary of how the independent components will function as a system.

4. Identification of the individual, and their contact information, designated to oversee the vibration and crack monitoring system(s); and daily recording activities required in this specification. A brief description of qualifications or resume of the individual is also required.

5. How site monitoring equipment will be deployed to continuously record vibration events,

including crack monitoring during construction activity. Depending on the equipment deployed and method chosen for networking, it is possible there will need to be both electrical and telecommunications connections available at multiple remote locations. The monitoring plan will address how the Contractor will provide utility service to the equipment, protect the equipment from potential vandalism and the elements, and monitor the overall system's day-to-day operation. The plan shall describe in reasonable detail the method and means the Contractor will use to identify and monitor existing cracks and document new cracks. For significant cracks or cracks that appear to have a high potential to migrate, it is recommended that the Contractor employ crack monitoring gauges.

6. Details for establishing and deploying an alarm system to announce immediate shut down of all site activities if a vibration event occurs which exceeds the PPV threshold established for the properties listed above. The alarm system shall include a phone modem which will dial cell phones of the Engineer and Contractor site personnel in the event of an exceedance.

7. Method for coordinating with the engineer whereby the contractor's retained licensed engineer will conduct a post-alarm survey in the event of a PPV threshold alarm occurrence.

8. Establish a protocol for the identification of the activity or equipment that caused the PPV threshold to be exceeded.

9. Description of the process which will be used to verify that the equipment will function as planned before starting work and the process which will be used to verify (daily) that the equipment remains in calibrated working order.

10. Detail a protocol including responsible parties to be notified if an exceedance occurs. This includes, but is not limited to the Engineer and the lead project inspector.

11. Daily activity log of vibration activity and crack monitors to ensure the identification of the cause of any vibration event. Depending on equipment deployed, crack monitors could be monitored remotely or by visual inspection. In either case, a daily inspection log shall be maintained either in written or electronic form.

12. Daily testing and logging of entire geophone/seismograph/communications network (start of day test). If the equipment fails the daily test, the Contractor shall correct the deficiency before proceeding with planned activities for that day or temporarily suspend work until the equipment is repaired or replaced. All daily logs will be available to the Engineer for review and a summary of daily logging will be provided in the post-condition survey.

151128.04 PRE-CONSTRUCTION SITE PREPARATION.

A. Crack Monitoring.

1. In accordance with the Monitoring Plan, the Contractor shall mark existing cracks in such a way that future observations would clearly indicate whether cracks remained unchanged, opened, closed, or propagated. The Contractor shall monitor and log all cracks and crack monitoring devices daily and immediately notify the Engineer of any observed change. It is recommended, but not required, to have and record metrological data for the close proximity to the project. Cracks that can be documented during the project to respond to changes in meteorological conditions will not require additional explanation in the final report.

2. Following is a list of companies that supply crack monitoring equipment; however other equipment of equal reliability and quality will be acceptable.
   - Tell-Tale Crack Monitors, RST Instruments Ltd.; 800.665.5599; www.rstinstruments.com

- Crack Monitoring Equipment, Geotest Instrument Corp.; 866.430.7645; www.crackguage.com
- Avonguard Crack Monitor, Avonguard Products USA; 800.244.7241; www.avonguard.com

B. Vibration Monitoring.
In accordance with the Monitoring Plan, all monitoring equipment shall be initially installed and maintained during the project in accordance with manufacturer's recommendations, calibration standards, and specifications. No site work can begin until all monitoring equipment is deployed and verified to be operating in accordance with factory recommendations and specifications.

C. Proof of Installation.
The Contractor shall demonstrate that the installed equipment will continuously and accurately measure vibrations, electronically log the vibration history (date/time stamp), and provide a communication notice system that notifies site personnel should the PPV threshold be exceeded. The monitoring equipment shall remain in-place and in operation throughout the project.

151128.05 VIBRATION LIMITS.
After a thorough conditions evaluation, the Contractor shall propose in the pre-construction survey a PPV level for the monitored structure. The PPV level proposed by the Contractor shall be determined by a qualified expert in the field of vibration monitoring. If the Engineer agrees that the level proposed by the Contractor will reasonably protect the structure, that PPV level will be added to the contract documents by mutual benefit for the specific property.

Preconstruction vibration monitoring was completed for 1126 Water Street and 1208 Water Street from March 2, 2021 to April 13, 2021. Results from this monitoring are presented in Attachment 1.

To ensure the PPV level is not exceeded, an alarmed monitoring system shall be implemented to signal any vibration event that equals or exceeds a threshold of 80% of the PPV level.

151128.06 DEMOLITION/CONSTRUCTION.

A. The Contractor shall periodically check to ensure that the monitoring system(s) are continuously operating within manufacturer's specifications during the project.

B. The Contractor shall immediately cease work if the alarm at the structure indicates the PPV threshold is reached or exceeded causing a vibration event. In the event of an exceedance the Engineer shall be notified immediately. The shut down shall remain in effect until the Contractor has, to the Engineer's satisfaction, identified the cause of the exceedance; addressed the potential for another exceedance by replacing faulty monitoring equipment; modified the work process; or provided a recommended change to the equipment being used. Work shall not resume until approved by the Engineer.

151128.07 POST-CONSTRUCTION SURVEY.
The Contractor shall perform a post-construction survey and analysis at the designated adjacent structure to determine if any structural changes are the result of the construction activity. The Contractor shall provide the Engineer with a copy of all post construction survey reports, daily log summaries for vibration and crack monitors, and analysis documents comparing pre and post structural condition prior to contract acceptance

151128.08 METHOD OF MEASUREMENT.
Vibration Monitoring will be measured as a lump sum unit of work.

151128.09 BASIS OF PAYMENT.

Vibration Monitoring will be paid for at the lump sum price. This price shall be full payment for pre-construction surveys; furnishing, installing, monitoring, and removing crack monitoring gauges; preparing and providing a report documenting crack monitoring during this project; furnishing, installing, monitoring, and removing vibration monitoring equipment; preparing and providing a report documenting vibration data collected during this project; notification of vibration events; post- construction surveys; reports; and all labor, equipment and materials necessary to complete the work as described. There will be no compensation for delays as the result of exceeding the PPV threshold or delays from faulty or damaged monitoring equipment. There will be no compensation for adjustment of construction activities or equipment to reduce the vibration levels to less than the maximum PPV, should an exceedance occur.

Attachment 1

ALLENDER BUTZKE ENGINEERS INC.
GEOTECHNICAL • ENVIRONMENTAL • CONSTRUCTION Q. C.

July 19, 2021

Calhoun-Burns and Associates, Inc.
1500 30th Street
West Des Moines, Iowa 50266
Attn: Mr. Lowell G. Miller, P.E.

RE: Preconstruction Vibration Survey
1126 and 1208 Water Street
Alden, Iowa 50006
CB&A No. 20182210
ABE PN 201224A

Dear Mr. Miller:

As authorized by Mr. Michael Vanderwert, P.E., Allender Butzke Engineers Inc (ABE) has completed the Preconstruction Vibration Survey for the buildings at 1126 and 1208 Water Street in Alden, Iowa. ABE installed three vibration monitors to monitor the background earthborne vibration levels.

Monitoring Procedure

Three locations were monitored over the span of approximately seven weeks. The locations are described as follows:

Location No. 1—West side of Building at 1126 Water Street, Serial No. 62230, monitored from 3/2/21 to 4/13/21. Sensor was oriented with the longitudinal direction parallel to Main Street.

Location No. 2—South end of Main Street bridge near northeast corner of building at 1208 Water Street, Serial Nos. 10740 & 72940, monitored from 3/2/21 to 4/13/21. Sensors were oriented with the longitudinal direction parallel to Main Street.

Location No. 3—North side of building at 1208 Water Street, at stoop of old basement walk-out door, Serial Nos. 15380, 10800 & 73010, monitored from 3/2/21 to 4/13/21. Sensors were oriented with the longitudinal direction parallel to Main Street.

Location No. 1 (MP_1)

Location No. 2 (MP_2)

Location No. 3 (MP_3)

The vibration monitors used for this survey were calibrated Sigicom Infra V12 (Serial Nos. 10740, 15380, &10800) and Sigicom Infra C12 (Serial Nos. 62230, 72940, & 73010). The monitors were set up inside steel security boxes and were bolted to the sidewalk/stoop concrete. The security boxes were padlocked to prevent tampering or theft. For this preconstruction survey, the monitors were configured to record in intervals between 5 seconds and 1 minute.

Monitoring Results

Graphs depicting the results of vibration monitoring are included in the appendix. The background vibrations measured at the three locations were generally below 0.05 inches per second. However, a few isolated vibration events with higher peak particle velocities (PPV) were measured at each location. The following Table No. 1 summarizes the maximum peak particle velocities measured at each location.

Table No. 1

Location	Date	Time	Max PPV	Frequency	Direction
1	3/15/21	9:34	0.066 in/s	55.5 Hz	T
2	4/3/21	20:45	1.05 in/s	54.0 Hz	V
3	4/8/21	15:37	0.984 in/s*	23.5 Hz	L

**Several PPV values exceeding 1.3 in/s were recorded at this location during 4/7/21 and 4/8/21. These higher measurements resulted in sensor overload warnings; therefore, they are not included in this table. These vibrations appeared to be the result of a contractor placing revetment stone between the river and the buildings.*

USBM RI 8507 Comparison

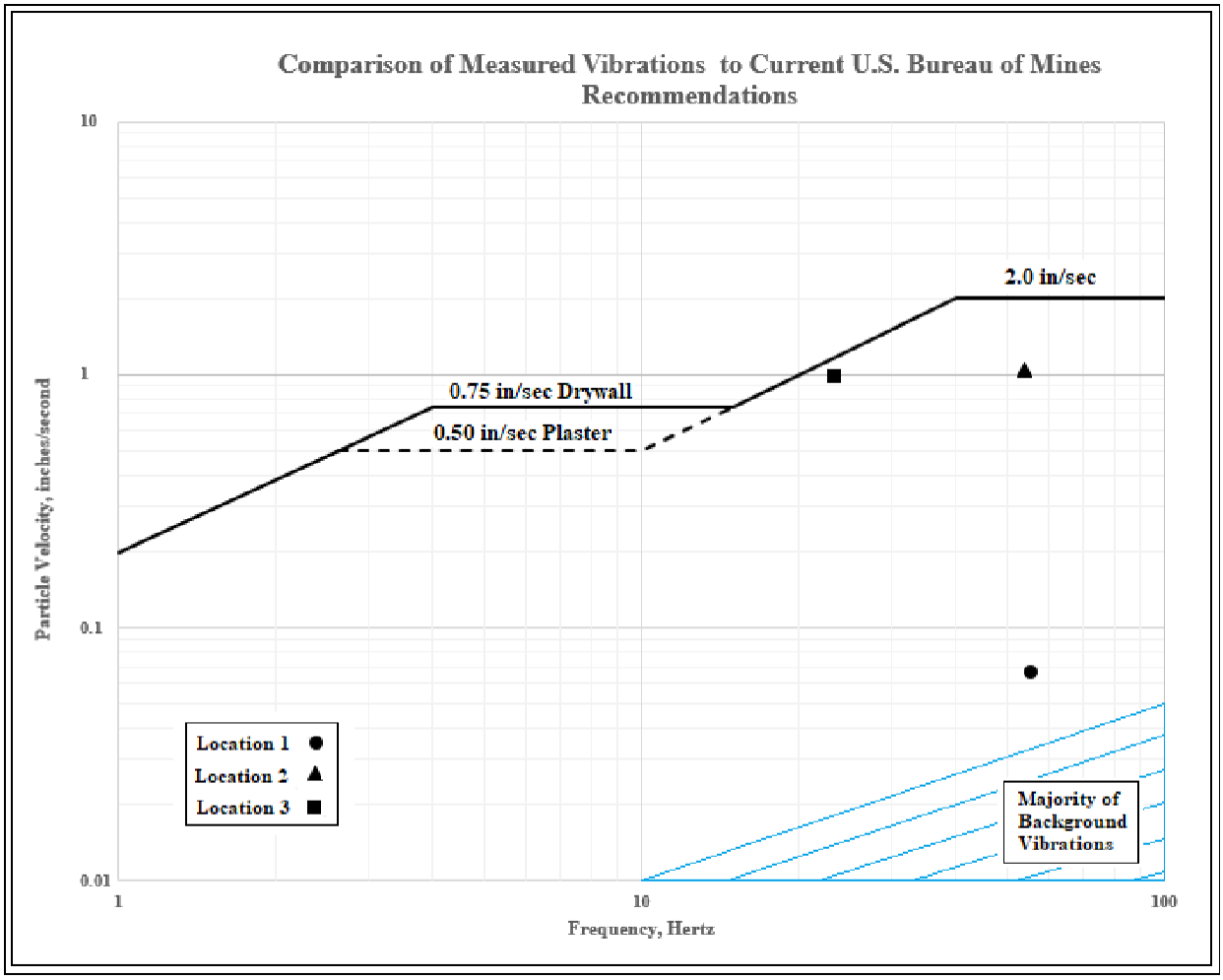
The U.S. Bureau of Mines published the Report of Investigations (RI-8507) entitled "Structure Response and Damage Produced by Ground Vibrations From Surface Mining" authored by David Siskind et al in 1980. This report presented the findings of 50 years of research and data from direct measurements of structural response and damage from surface mine production blasts on a variety of residential structures.

RI-8507 determined that the damage potential for low frequency blasts (less than 40 Hz) is much higher than that of high frequency blasts (greater than 40 Hz). For low frequency blasts,the report recommends safe vibration levels to preclude threshold damage for residential structures of 0.75 inches per second (in/sec) for modern gypsum drywall construction and 0.50 in/sec for older lath & plaster construction. For high frequency blasts, the report recommends a maximum particle velocity of 2.0 in/sec for all residential structures. RI-8507 defines threshold damage as the loosening of paint, small plaster cracks at joints, or the lengthening of old plaster cracks.

Since vibrations from construction activity are similar to those produced from blasting, the recommendations of RI-8507 are commonly referenced to determine the potential effects of construction vibrations on nearby structures. The following Figure No. 1 compares the highest

measured vibrations at each of the three monitoring locations with respect to the RI-8507 recommendations.

Figure No. 1



As shown in Figure No. 1, the highest measured vibrations at Location Nos. 2 and 3 were slightly lower than the U.S. Bureau of Mines RI-8507 recommendations. The highest measured vibrations at Location No. 1 were well below RI-8507 recommendations.

Conclusion

Background vibration levels at this site generally appeared lower than 0.05 inches per second, however, several higher vibrations were measured at each location. Aside from the placement of revetment stone near Location No. 3 on 4/7-8/21, we are not aware of the source of the measured vibrations and background levels could vary throughout the year with river levels, groundwater levels, vehicle traffic patterns, frozen ground, truck traffic, or other vibration

causing activities or events. A long term (one year or more) study may show higher background vibration levels.

We appreciate the opportunity to provide our vibration monitoring services for this project. If you have any questions or need further assistance, please contact us at your convemence.

Respectfully submitted,
ALLENDER BUTZKE ENGINEERS INC.

Keith Kimsey

Keith Kimsey, P.E.
Project Engineer

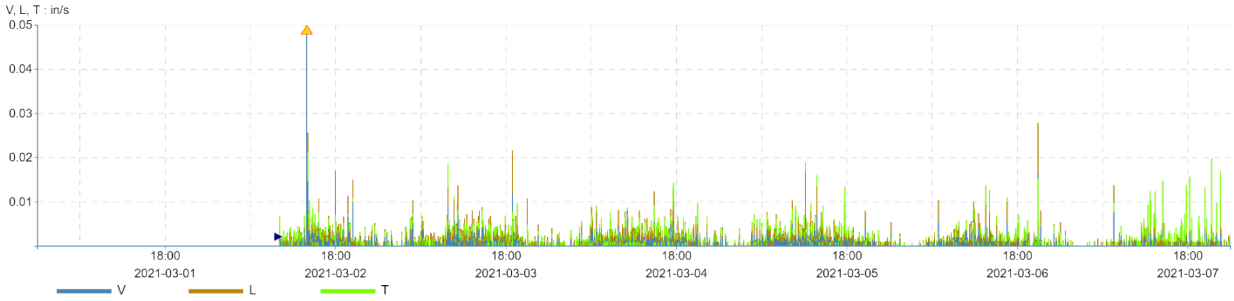
arm, P.E.
David Logeng Engineer
Principal

1 Email Above

APPENDIX

MP_1,

Sensor: C12 #: 62230 Standard: (52) ISEE Seismograph 1 in/s 2-250Hz Master(s) serial no.: 62230
Unit: in/s Latest calibration: 2020-09-17 Quantity: Velocity Interval time: 1 min



MP_1,

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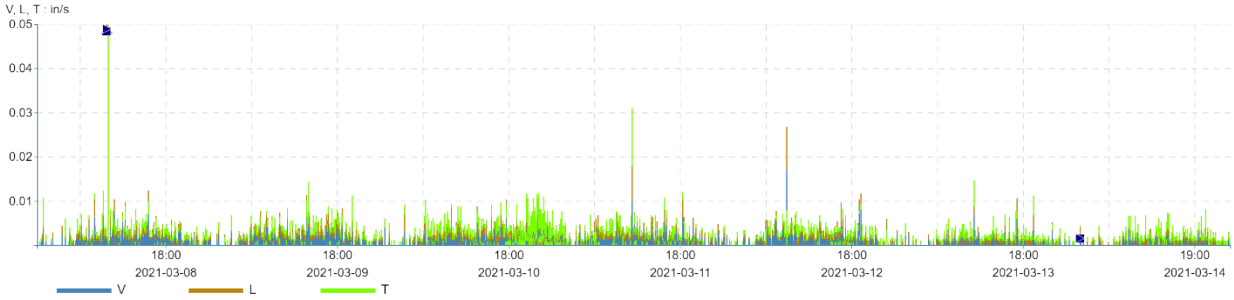

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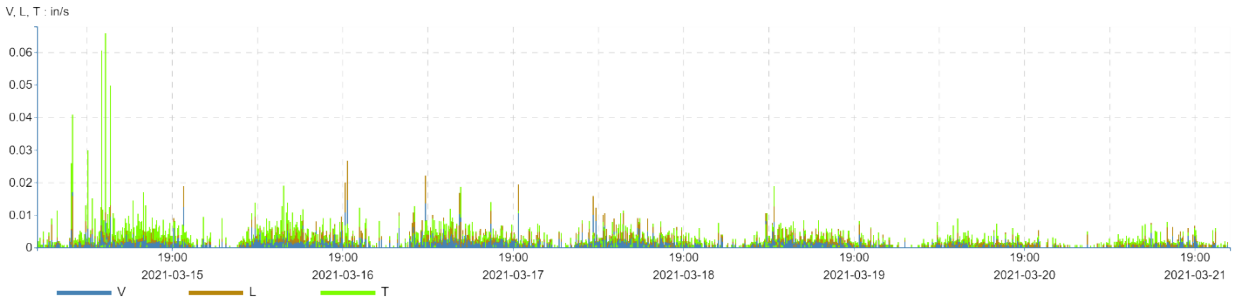

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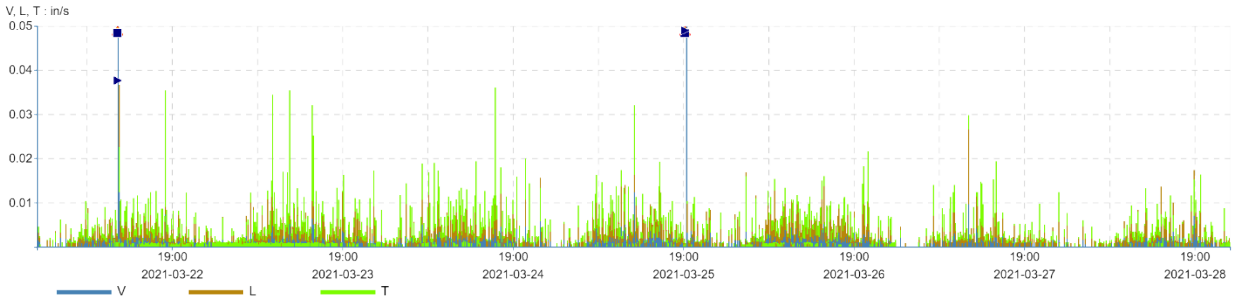

MP_1,

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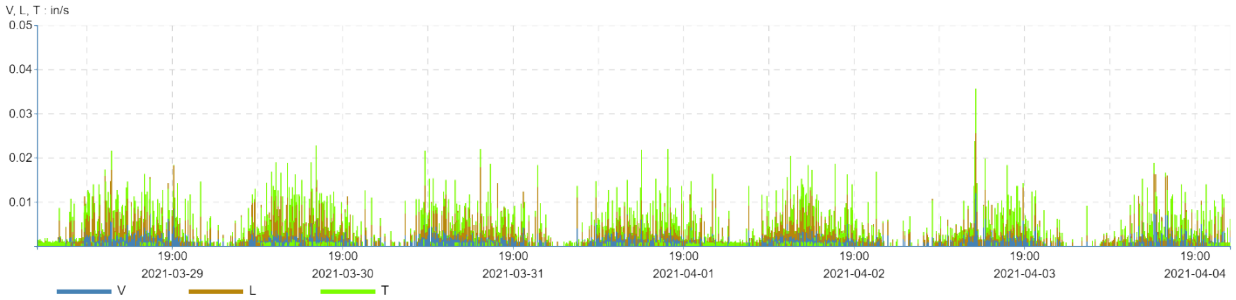

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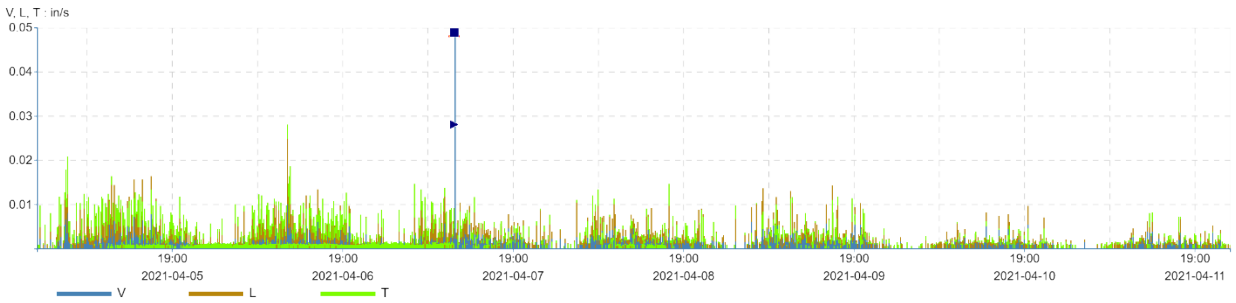

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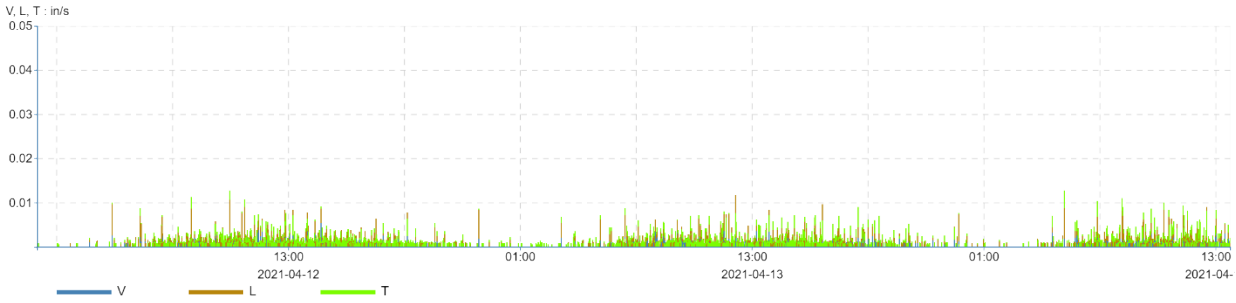

MP_2,

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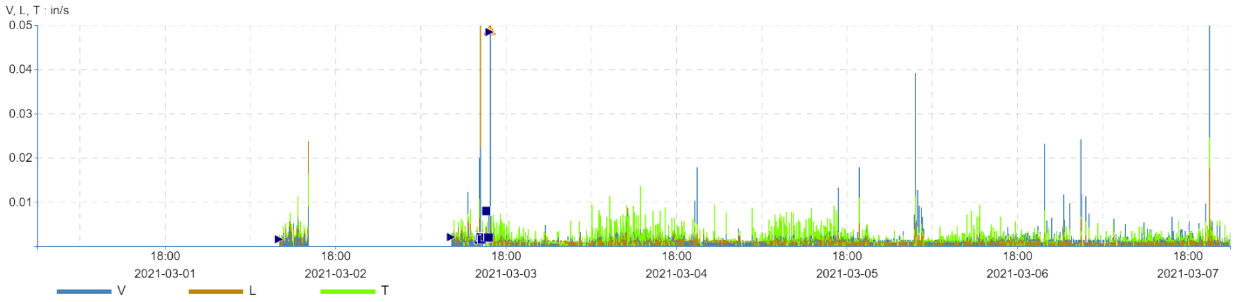

MP_2,

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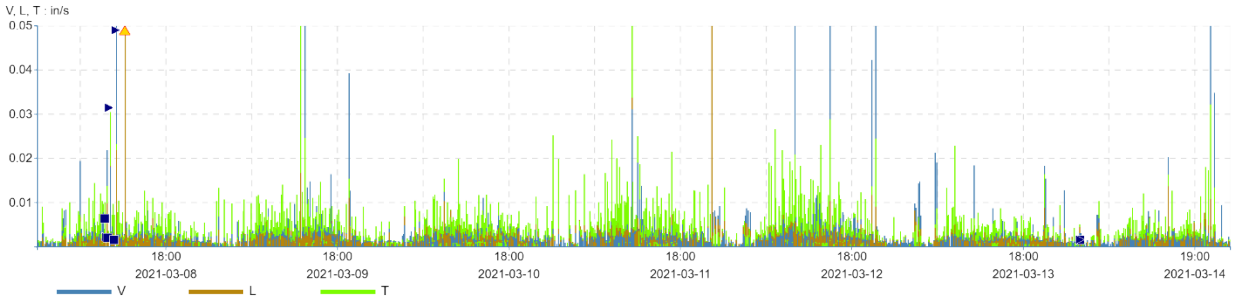

MP_2,

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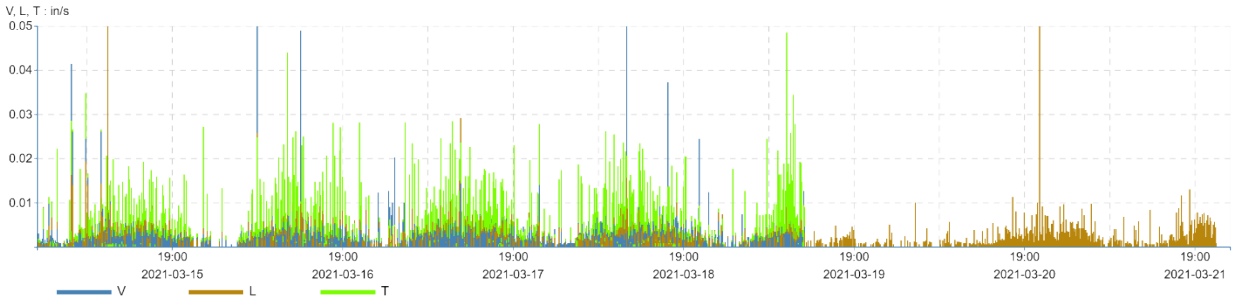

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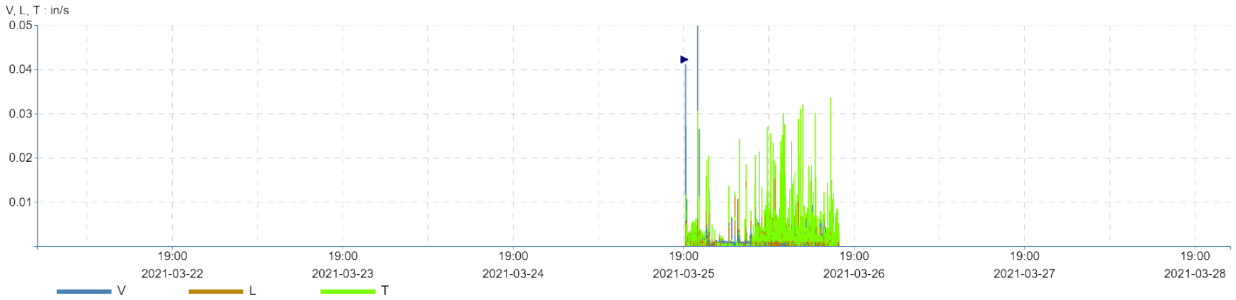

MP_2A,

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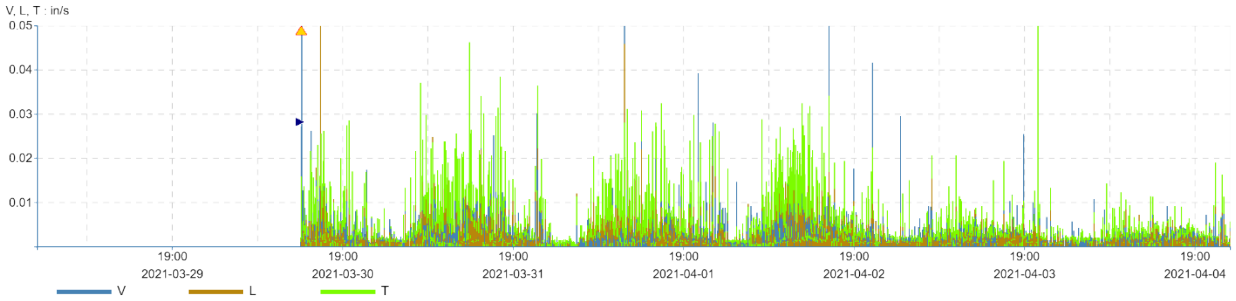

MP_2A,

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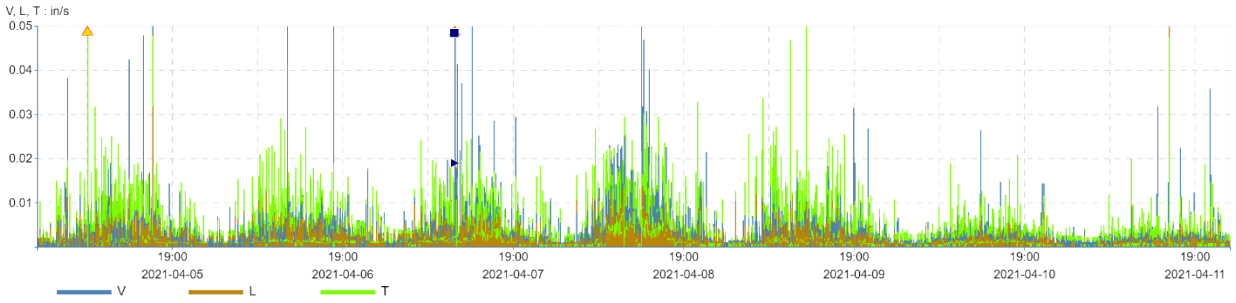

MP_2A,

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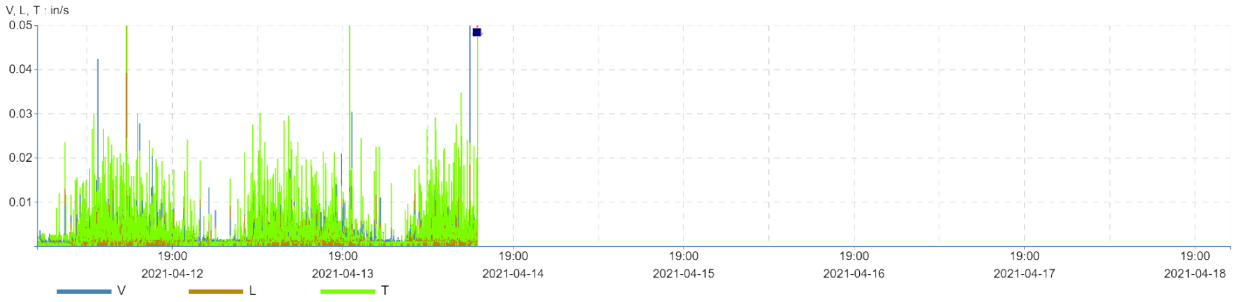

MP_3,

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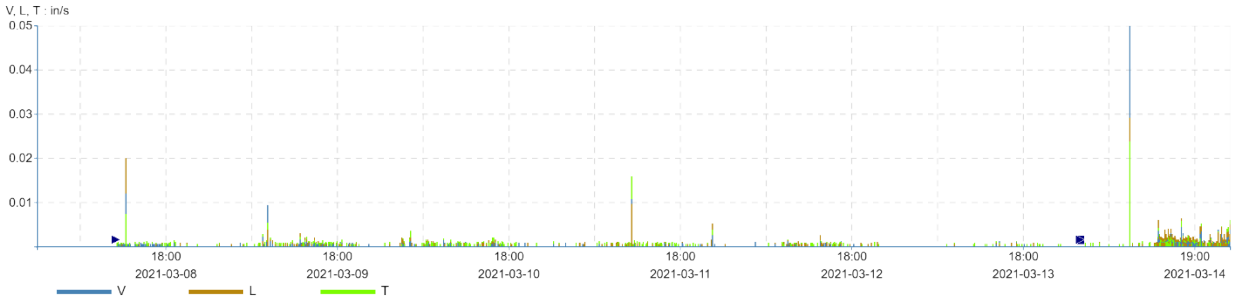

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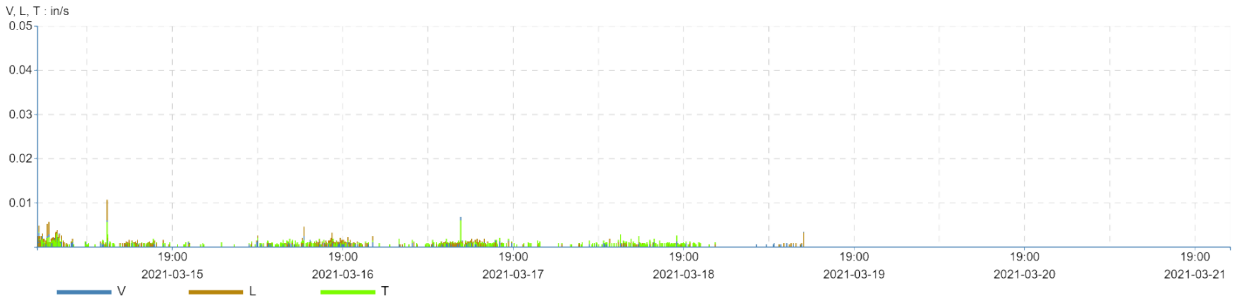

MP_3A,

Sensor: C12 #: 73010 Standard: (52) ISEE Seismograph 1 in/s 2-250Hz Master(s) serial no.: 73010
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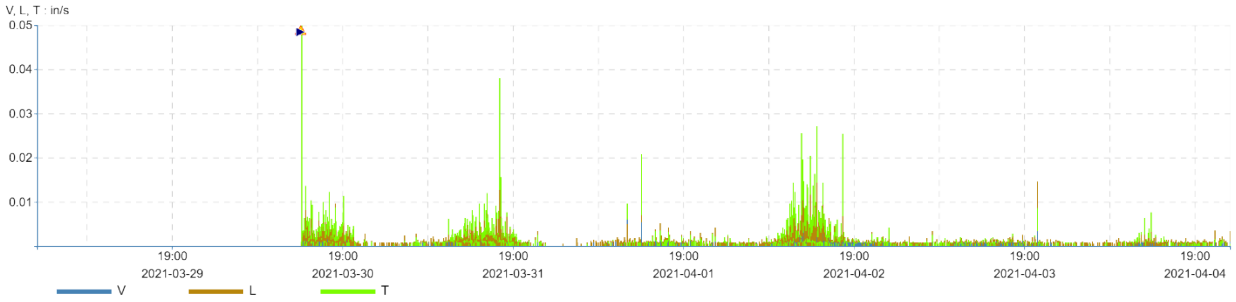

MP_3A,

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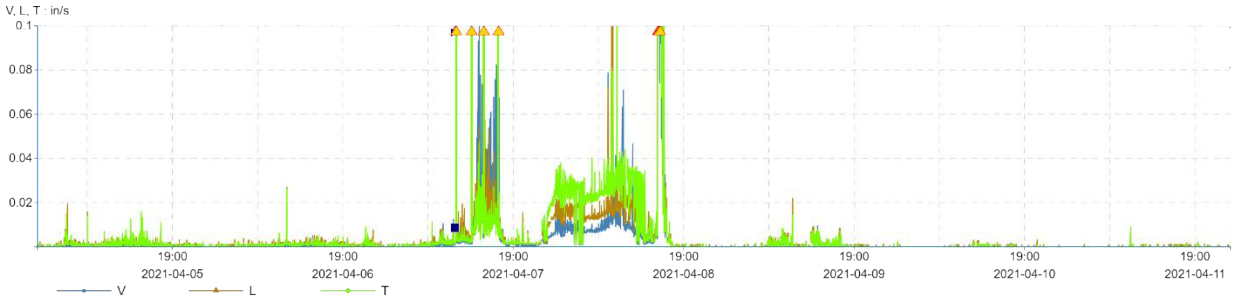

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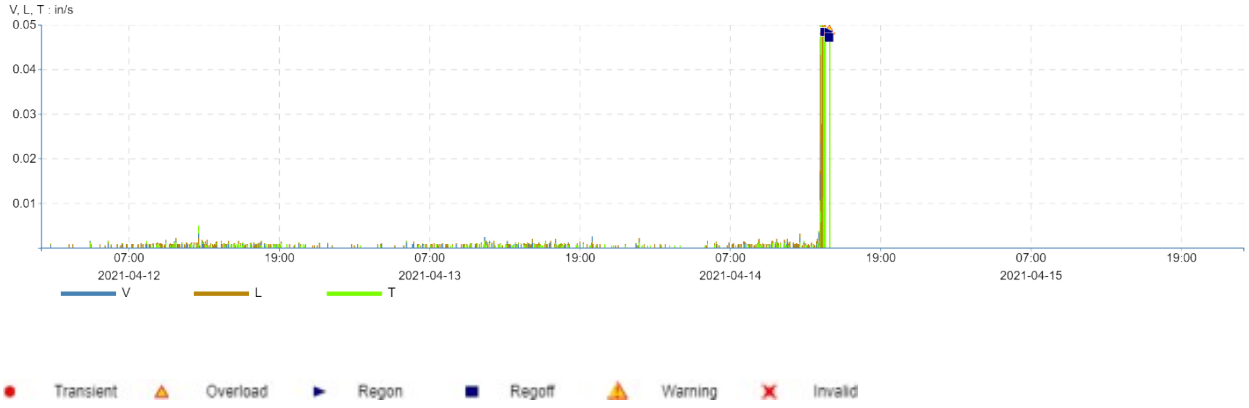

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