

**Ambient Ground Vibration Measurements
at the Hanford, Washington LIGO Site**

Appendix I

LIGO-C950581-00-□

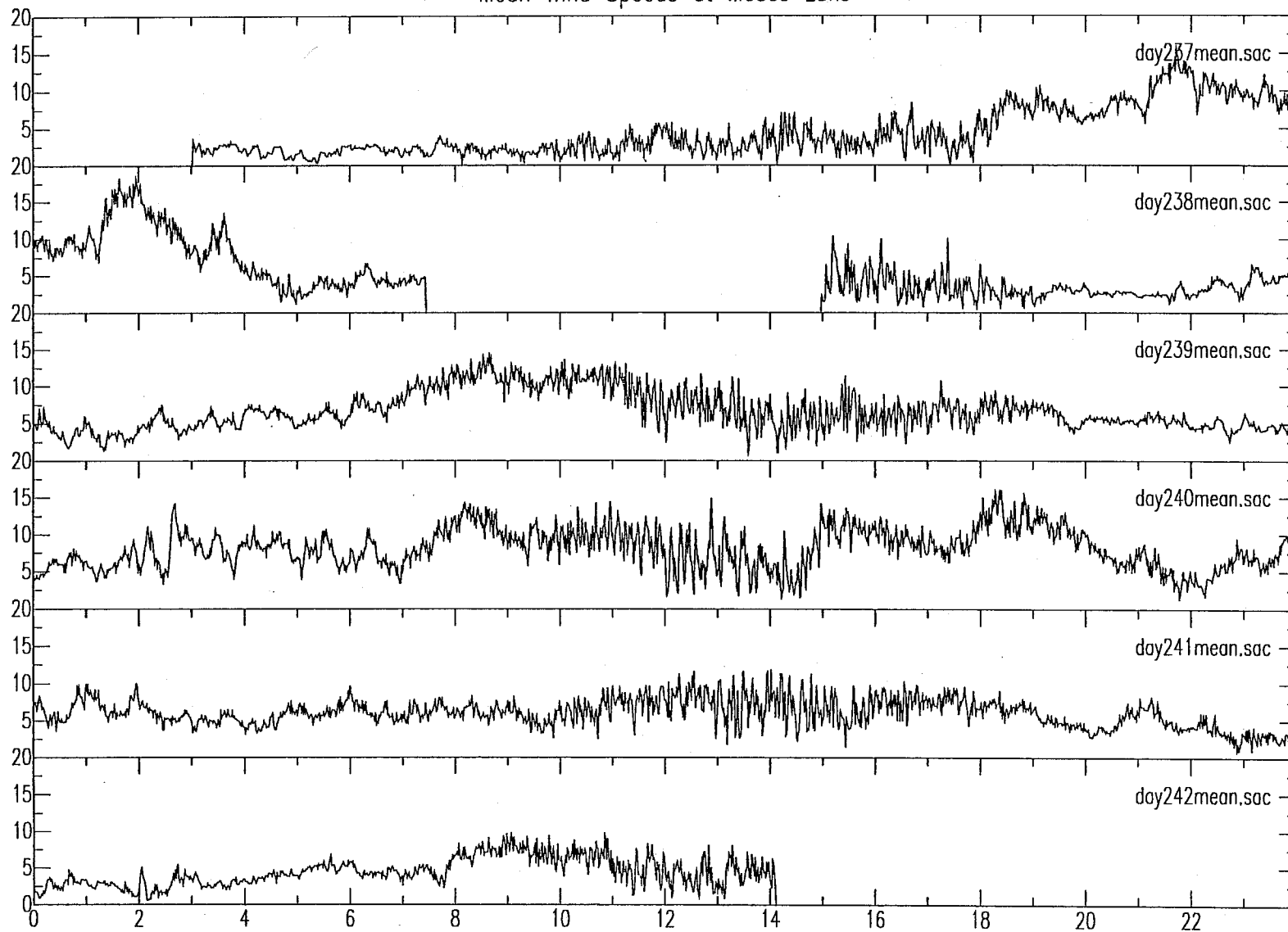
Large Structure/Wind Noise Plots

Moses Lake Wind Speed Plots

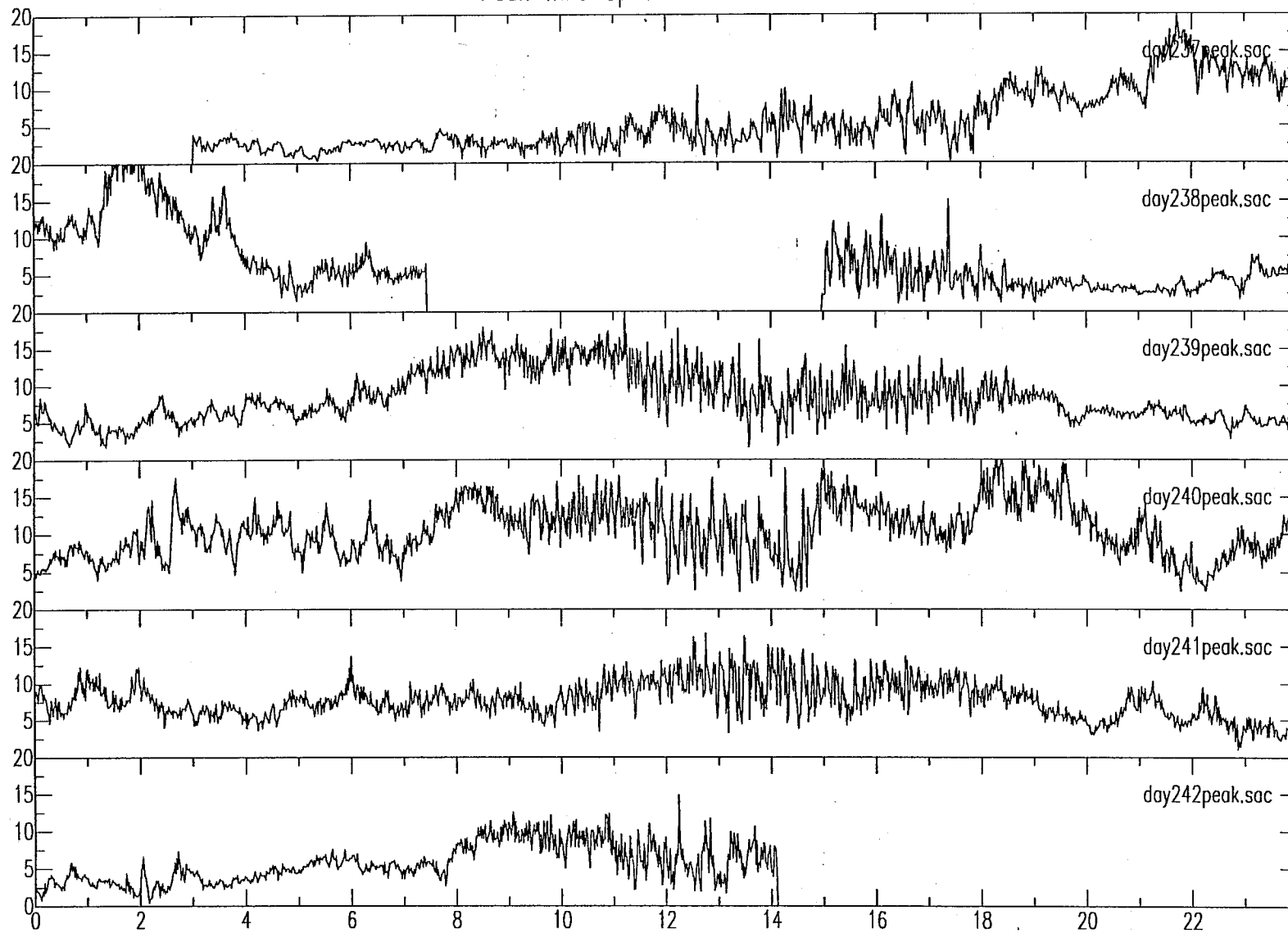
Moses Lake Daily Mean Wind Speeds (scale in m.p.h.)

Moses Lake Daily Mean Wind Speeds (scale in m.p.h.)

Mean Wind Speeds at Moses Lake



Peak Wind Speeds at Moses Lake



Moses Lake Wind Speed Plots

Wind Effects at JAL Airplane Hangar

Day 237-238 Hourly Seismic Acceleration Spectrograms

Hour 20 20:00 - 21:00 GMT
Hour 21 21:00 - 22:00 GMT
Hour 22 22:00 - 23:00 GMT
Hour 23 23:00 - 00:00 GMT
Hour 00 00:00 - 01:00 GMT
Hour 01 01:00 - 02:00 GMT
Hour 02 02:00 - 03:00 GMT
Hour 03 03:00 - 04:00 GMT
Hour 04 04:00 - 05:00 GMT
Hour 05 05:00 - 06:00 GMT

Day 237-238 Hourly Wind Speed Plots

Hour 20 20:00 - 21:00 GMT
Hour 21 21:00 - 22:00 GMT
Hour 22 22:00 - 23:00 GMT
Hour 23 23:00 - 00:00 GMT
Hour 00 00:00 - 01:00 GMT
Hour 01 01:00 - 02:00 GMT
Hour 02 02:00 - 03:00 GMT
Hour 03 03:00 - 04:00 GMT
Hour 04 04:00 - 05:00 GMT
Hour 05 05:00 - 06:00 GMT

Day 238 Vertical Component Displacement Spectra

Hour 01 2000 seconds
Hour 01 2640 seconds
Hour 04 2540 seconds
Hour 04 3140 seconds

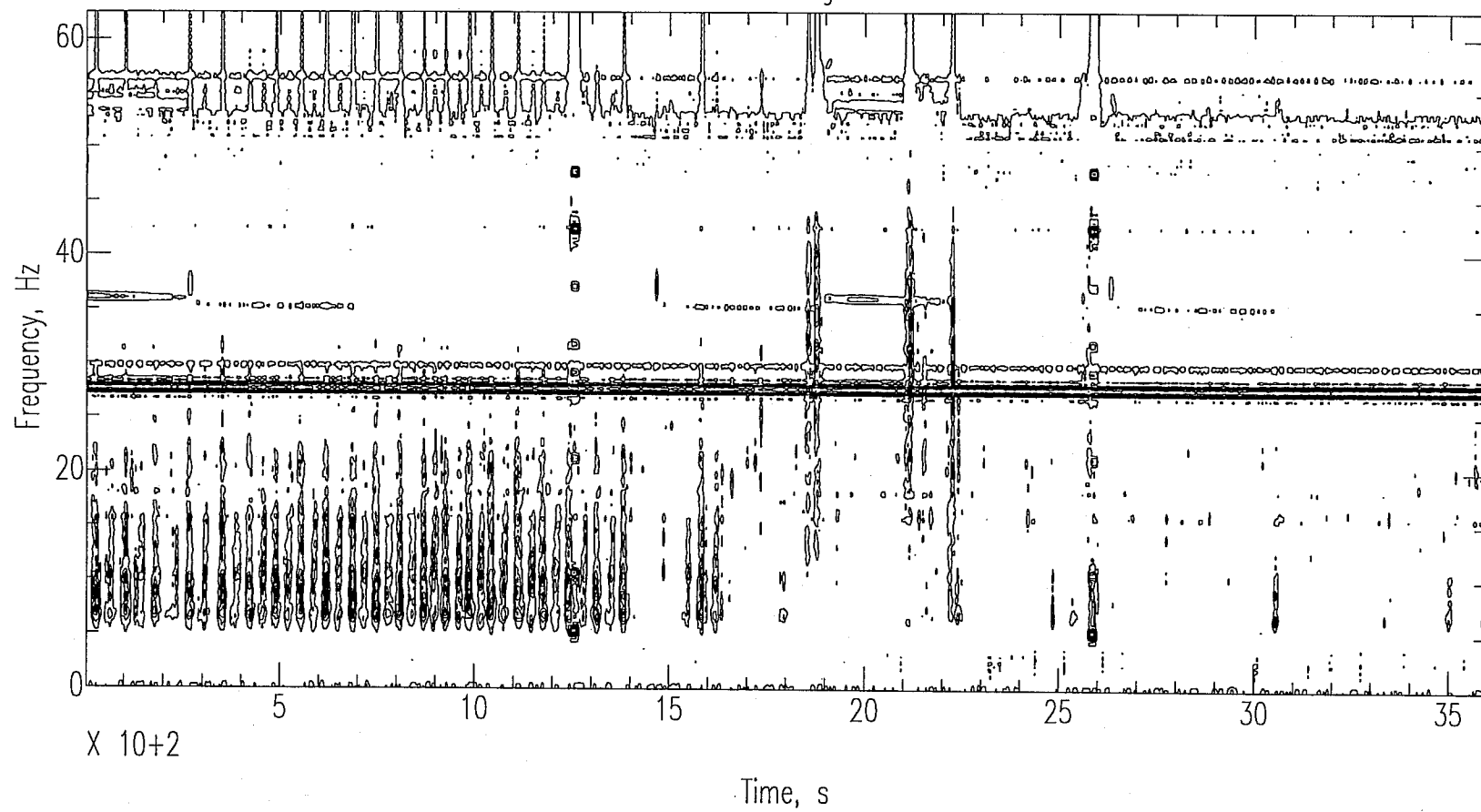
Day 238 North Component Displacement Spectra

Hour 01 2000 seconds
Hour 01 2640 seconds
Hour 04 2540 seconds
Hour 04 3140 seconds

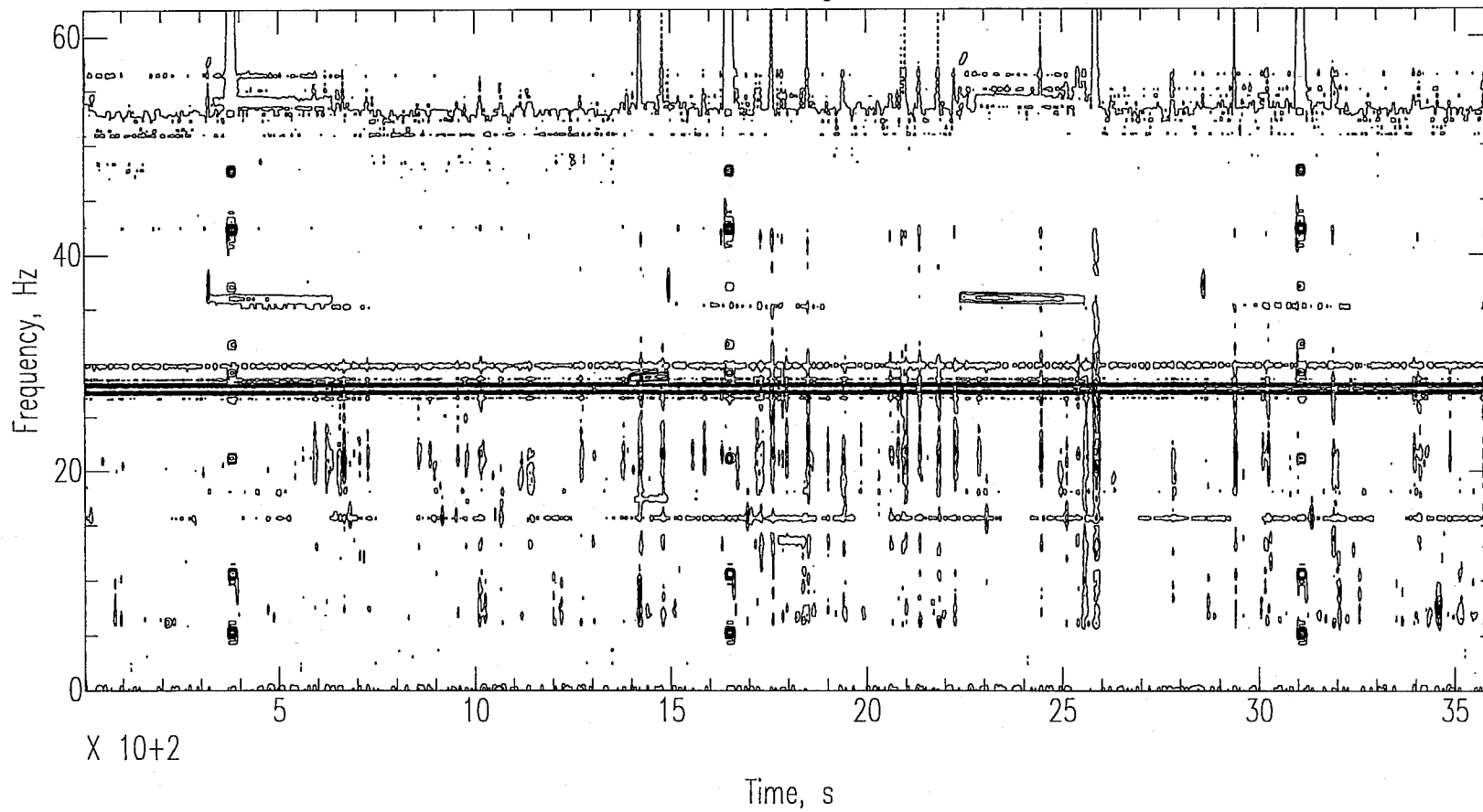
Day 238 West Component Displacement Spectra

Hour 01 2000 seconds
Hour 01 2640 seconds
Hour 04 2540 seconds
Hour 04 3140 seconds

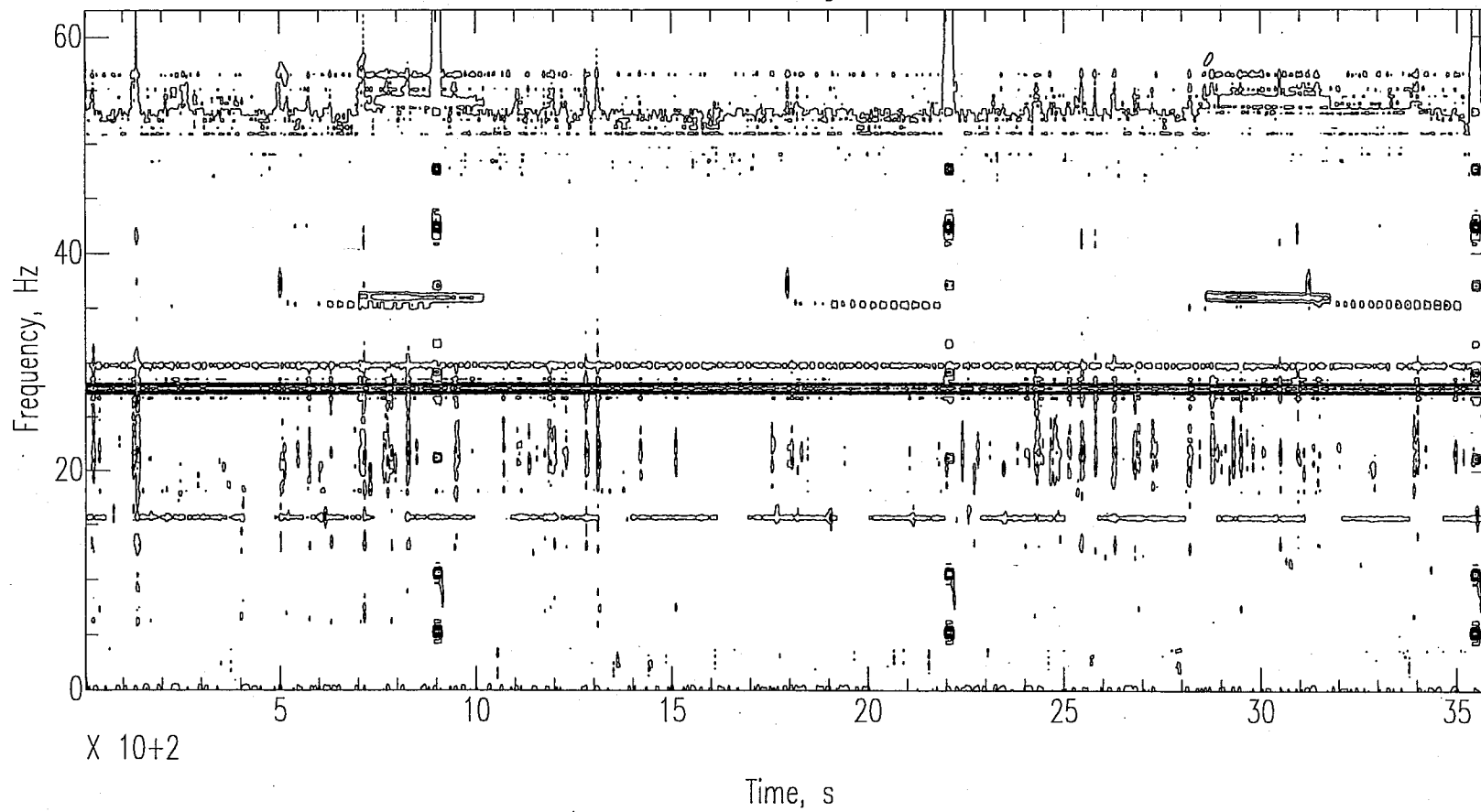
Moses Lake JAL Hangar 237.2000.1

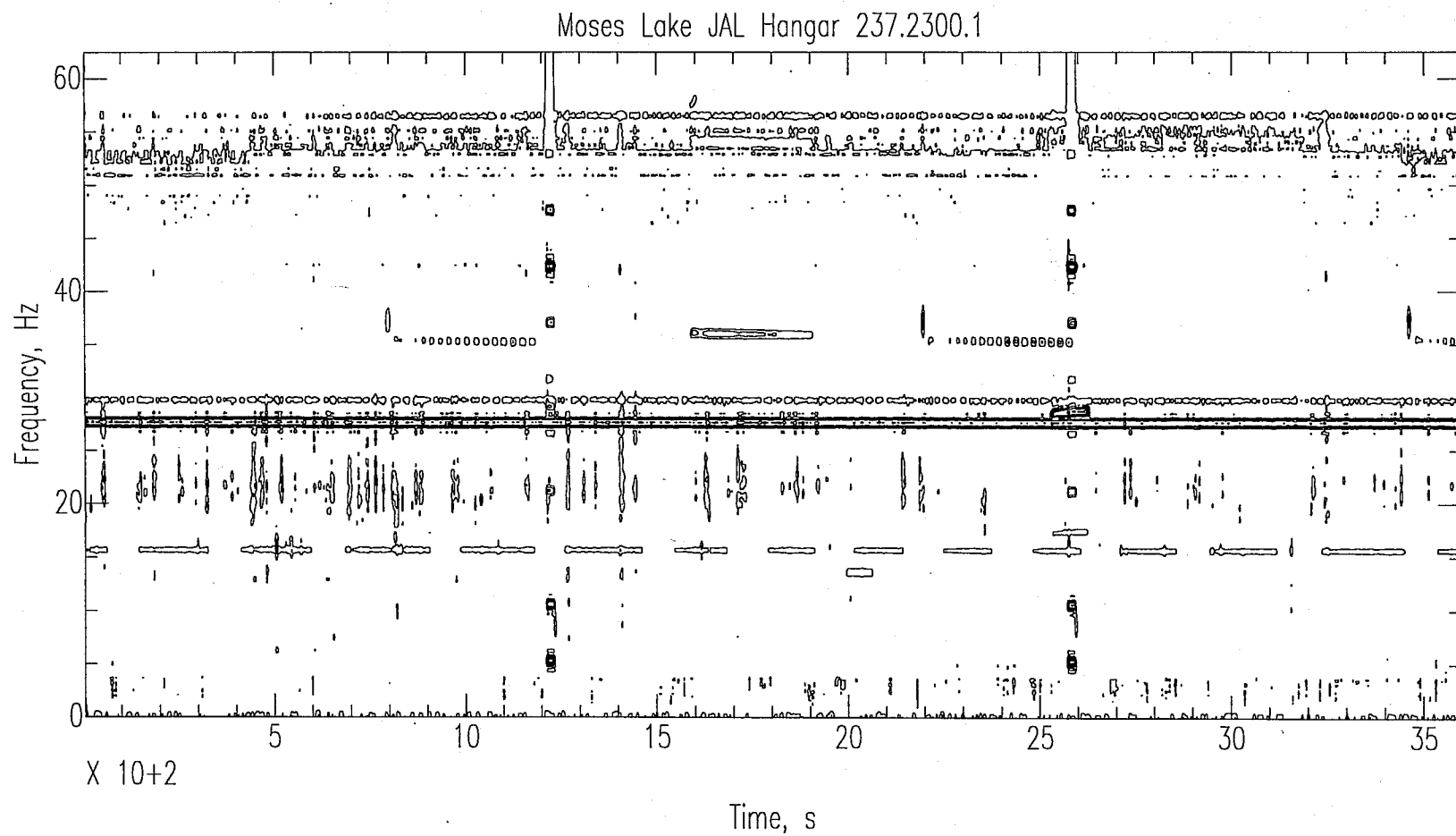


Moses Lake JAL Hangar 237.2100.1

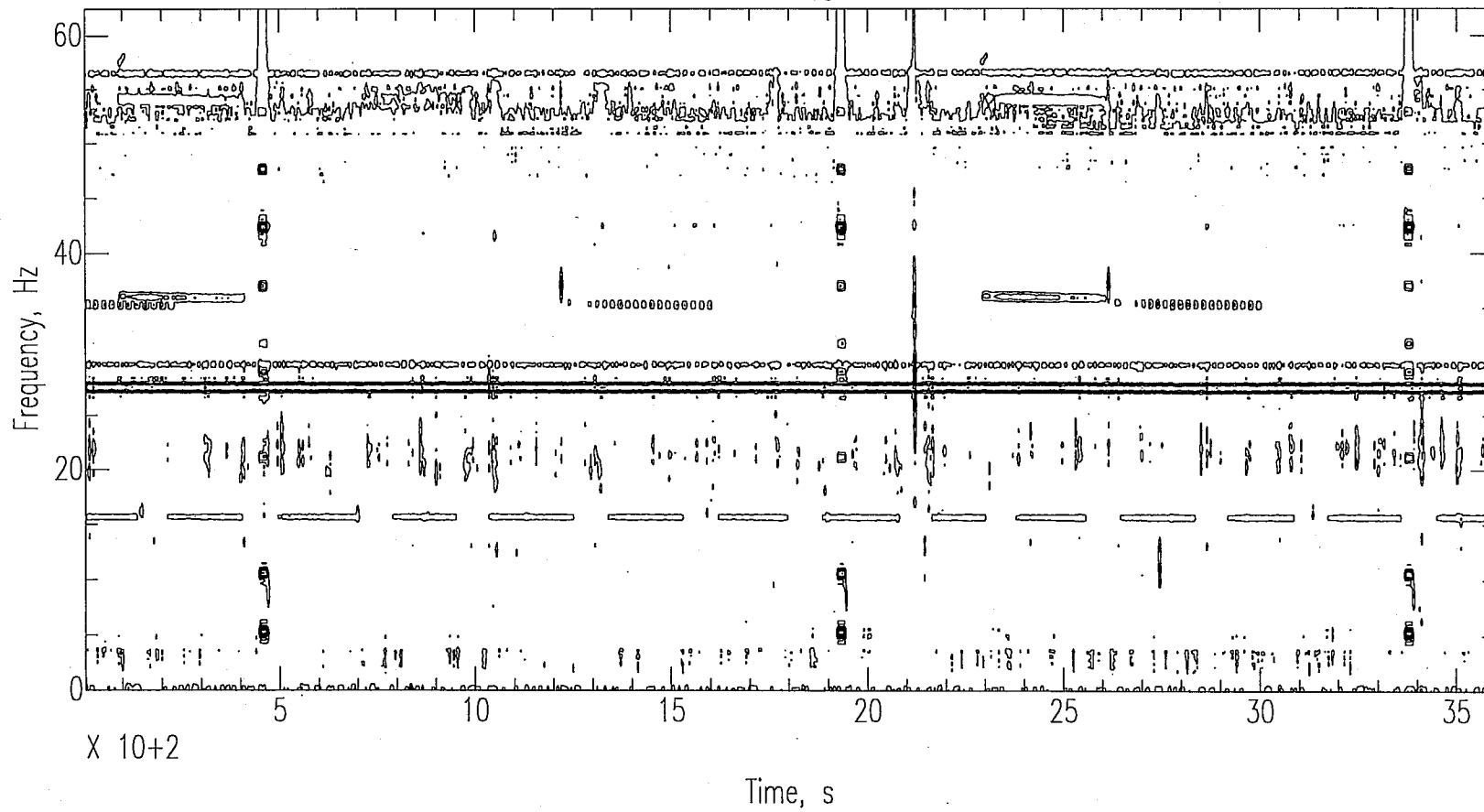


Moses Lake JAL Hangar 237.2200.1

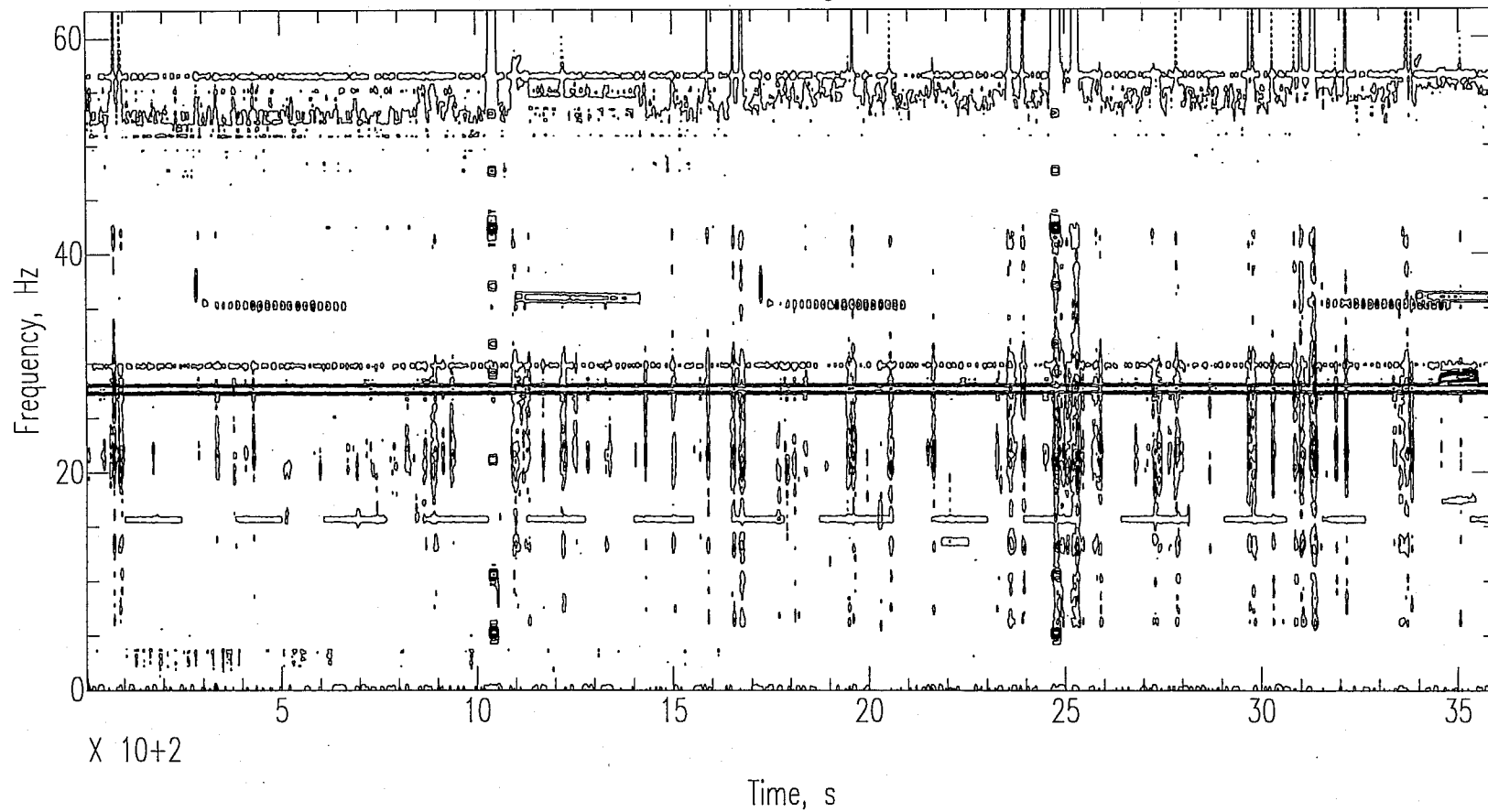




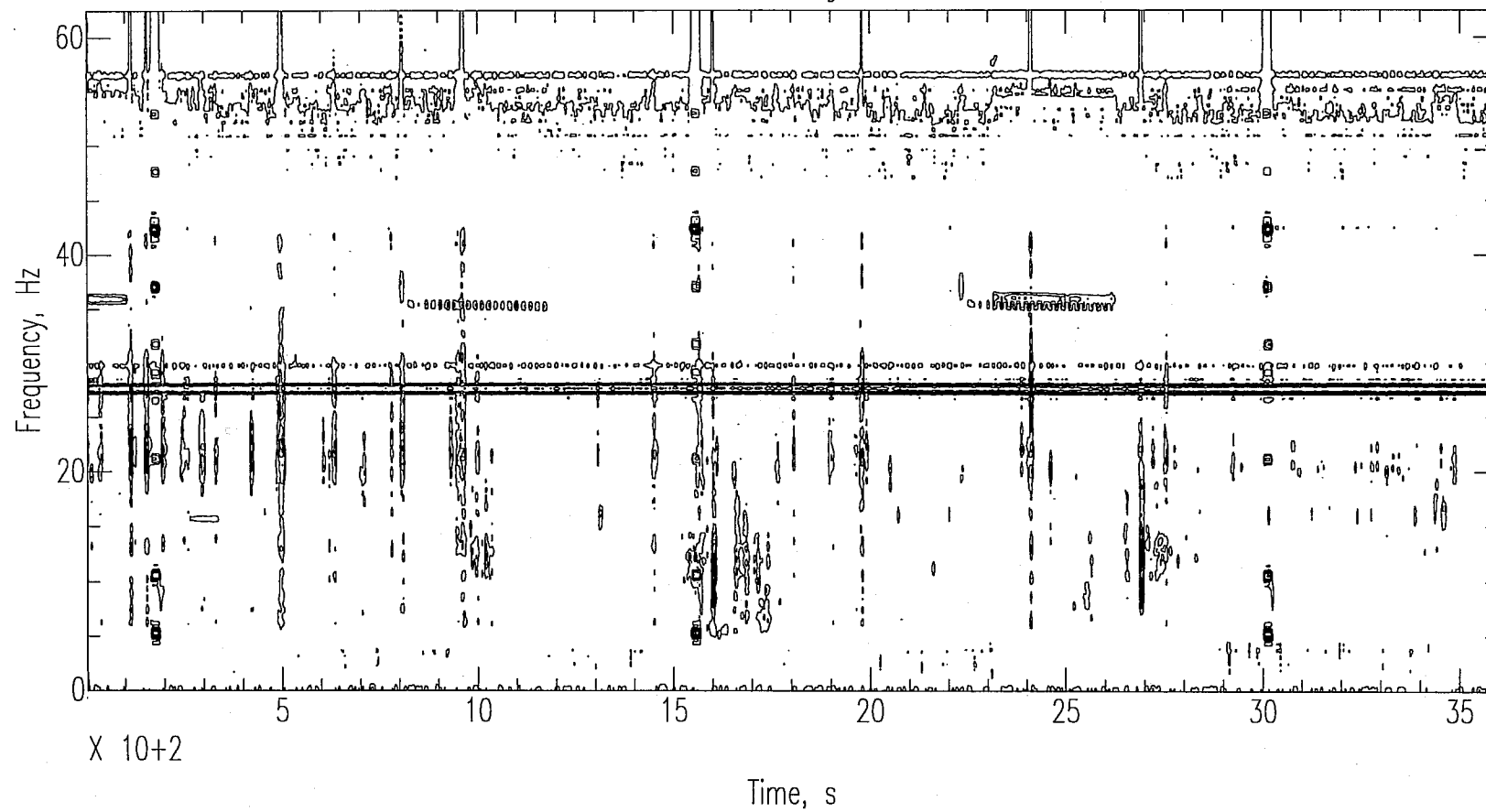
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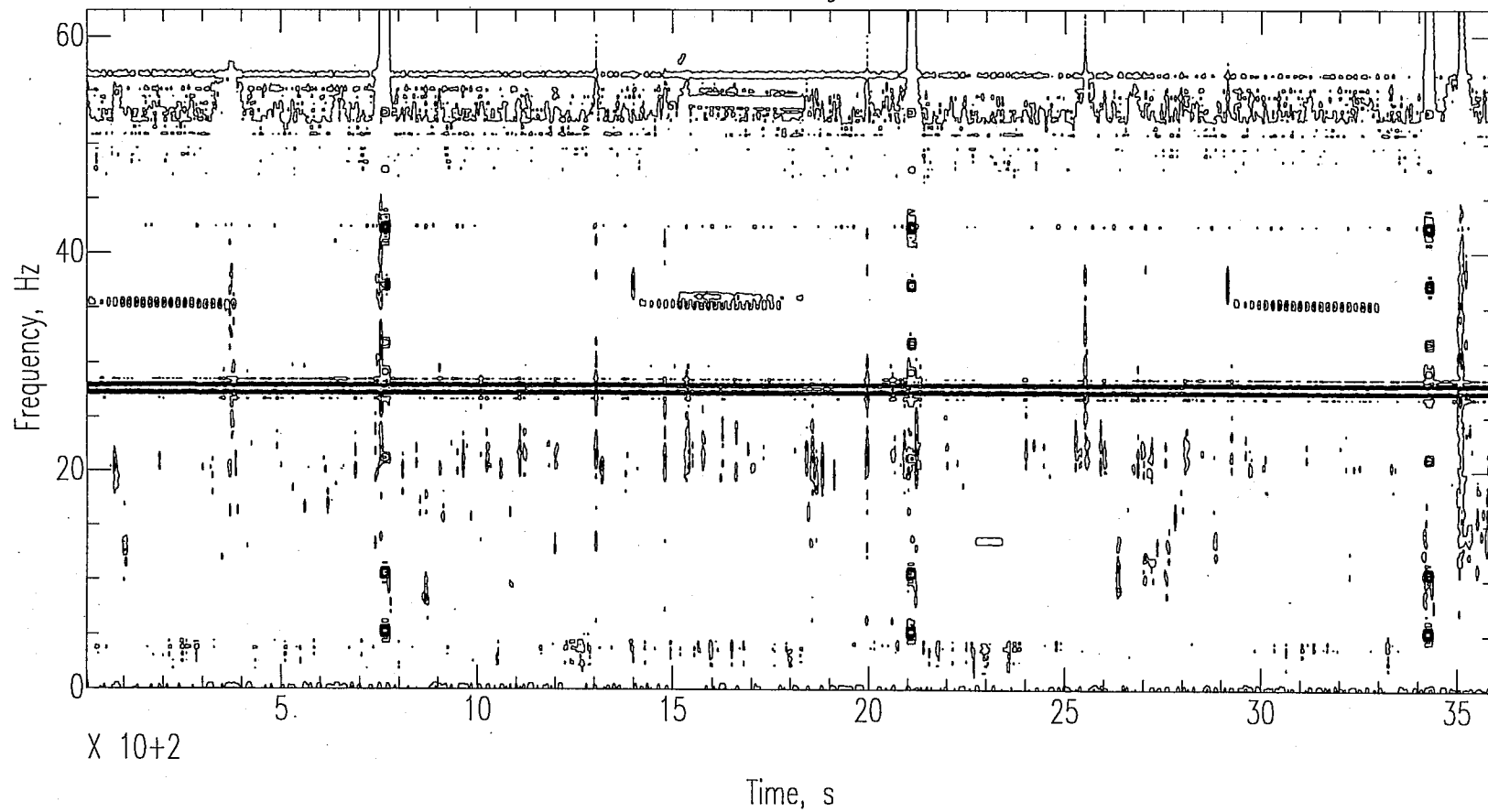
Moses Lake JAL Hangar 238.0100.1



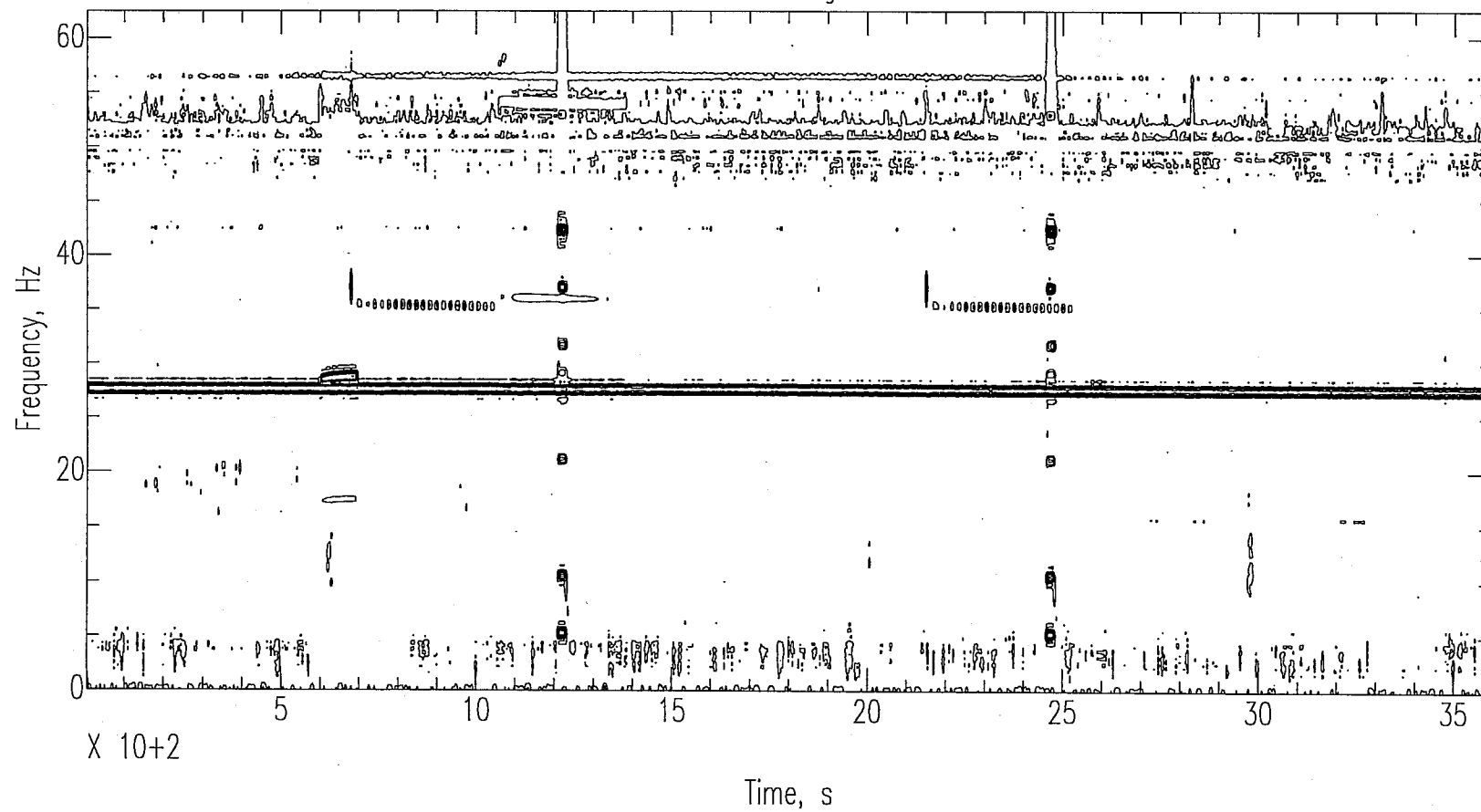
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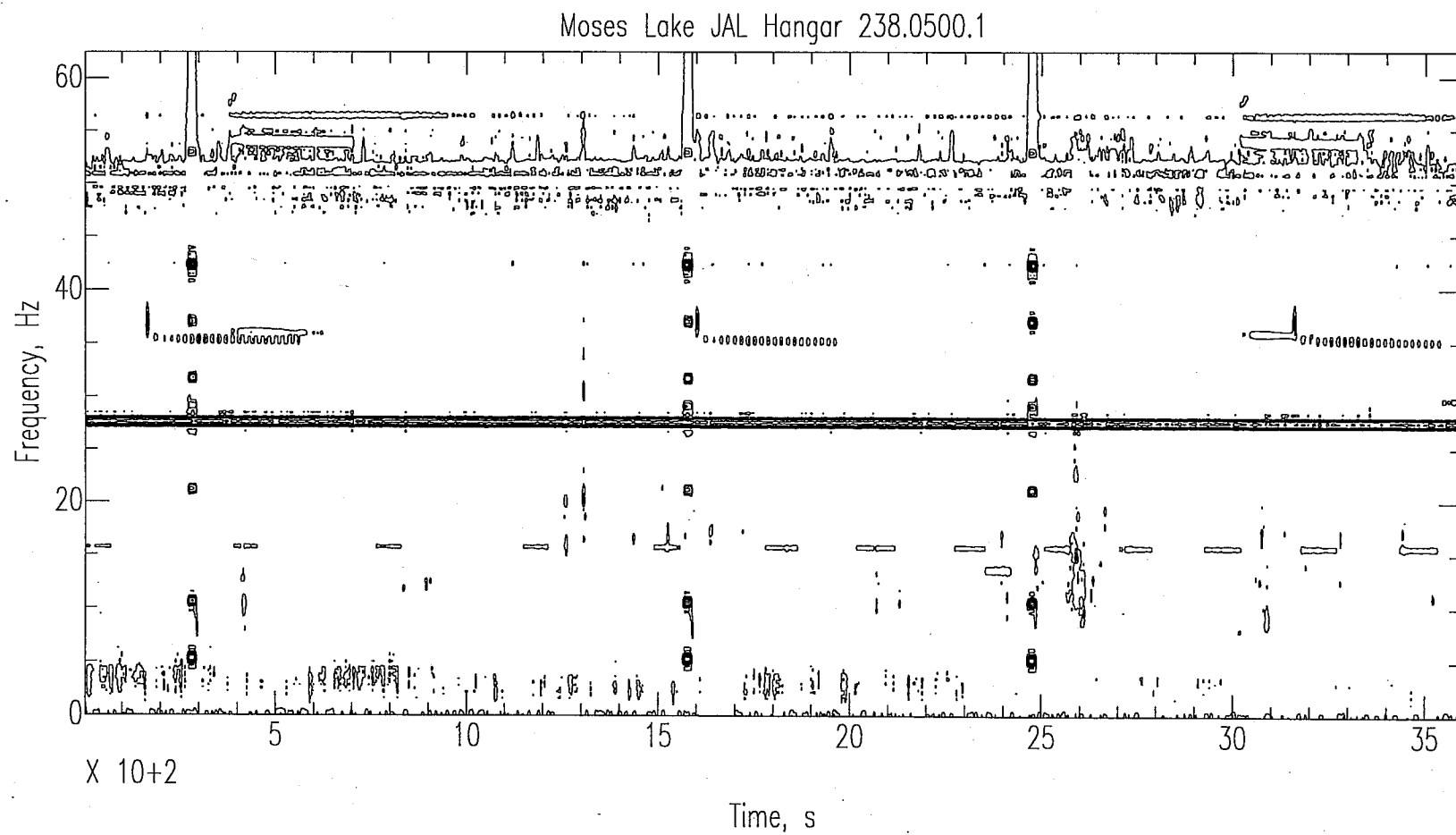


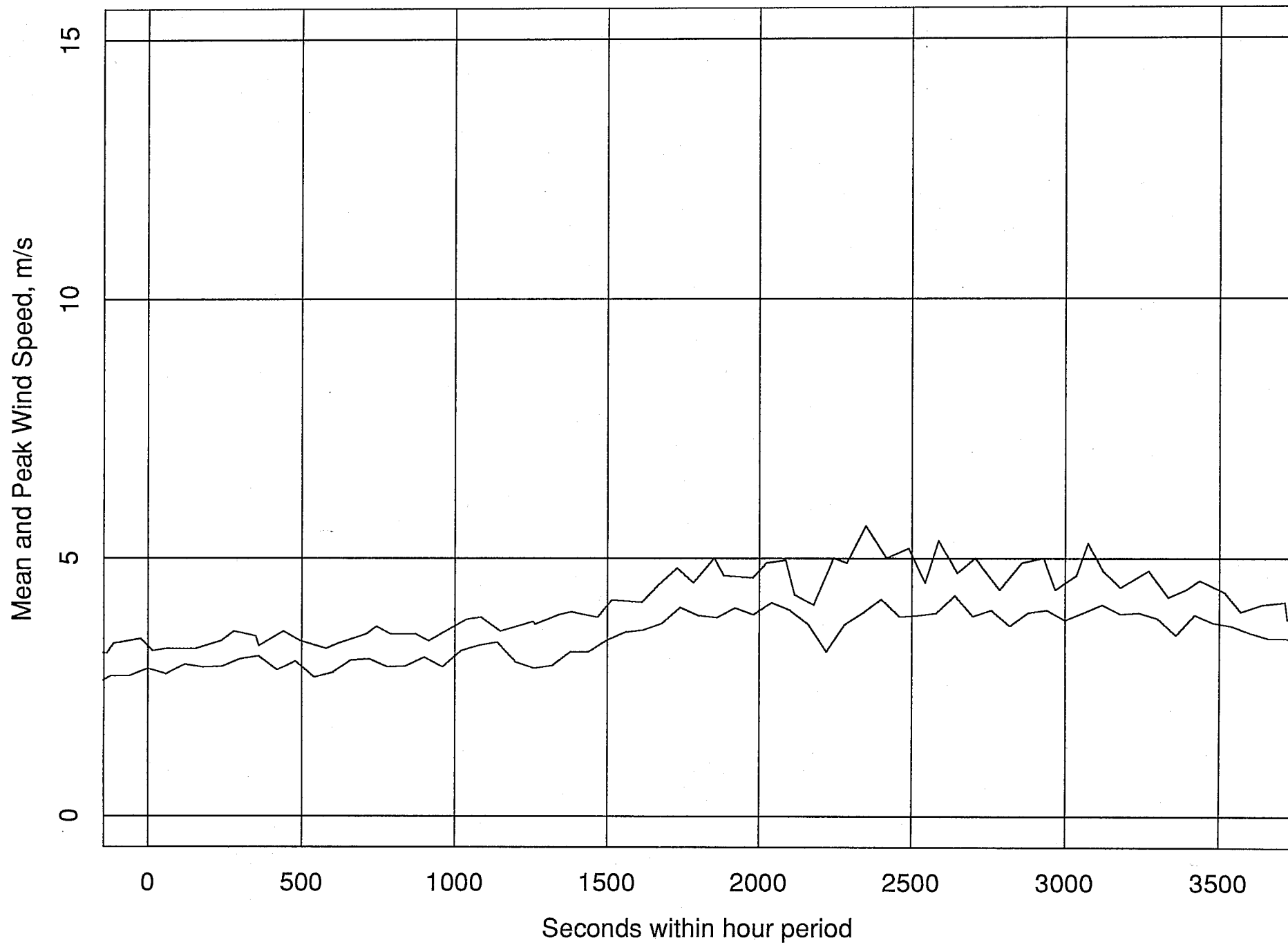
Moses Lake JAL Hangar 238.0300.1

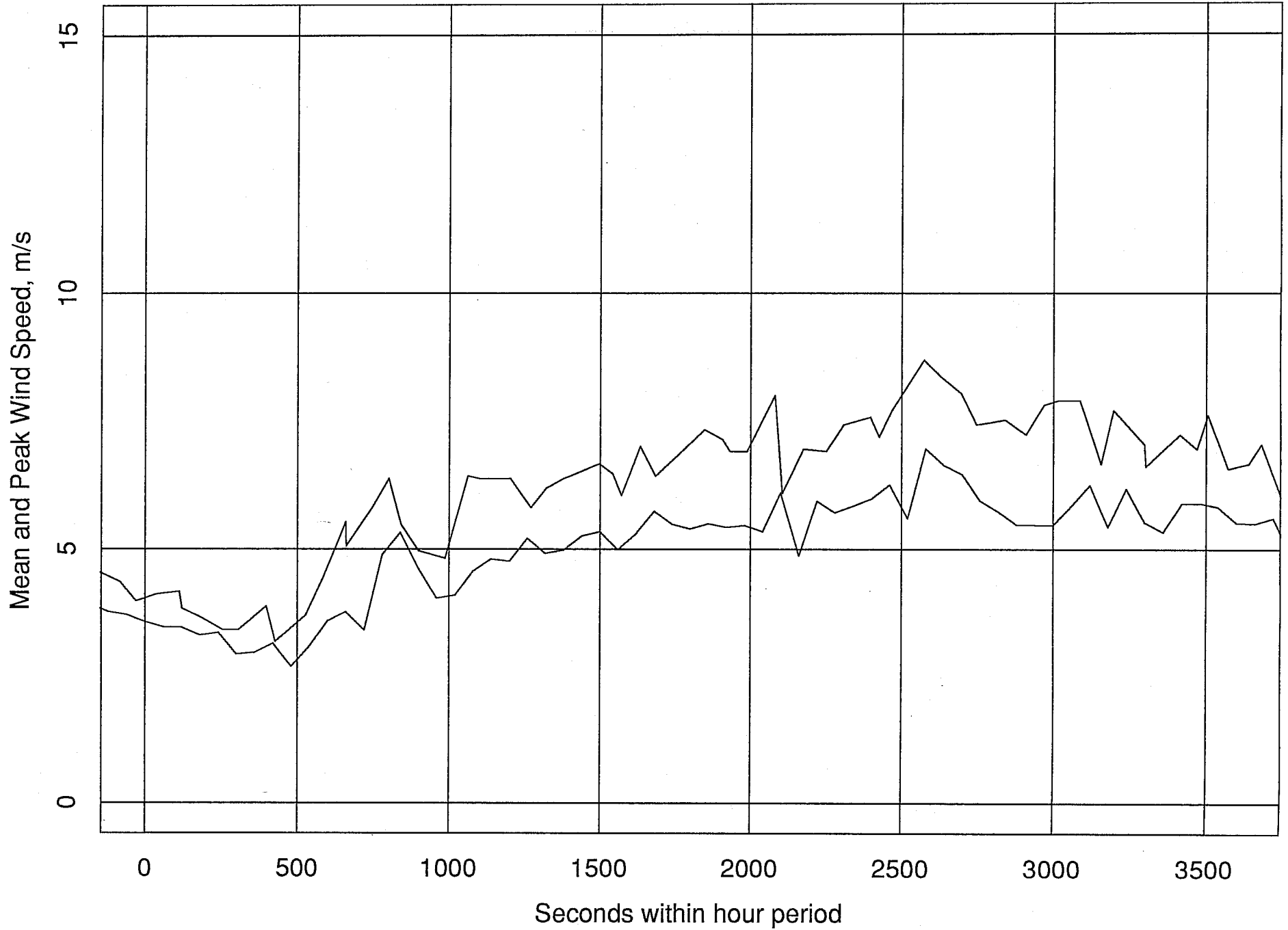


Moses Lake JAL Hangar 238.0400.1

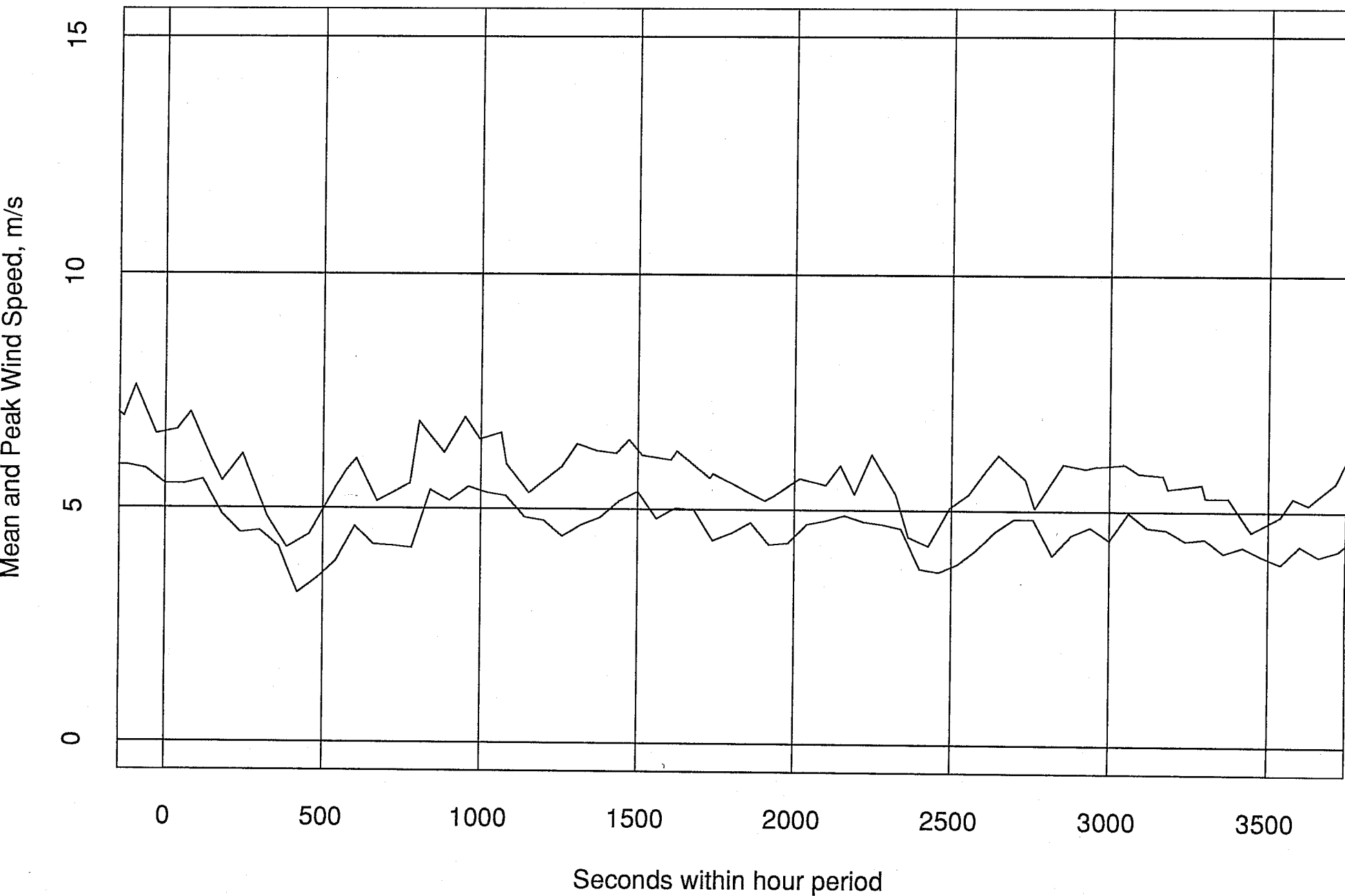




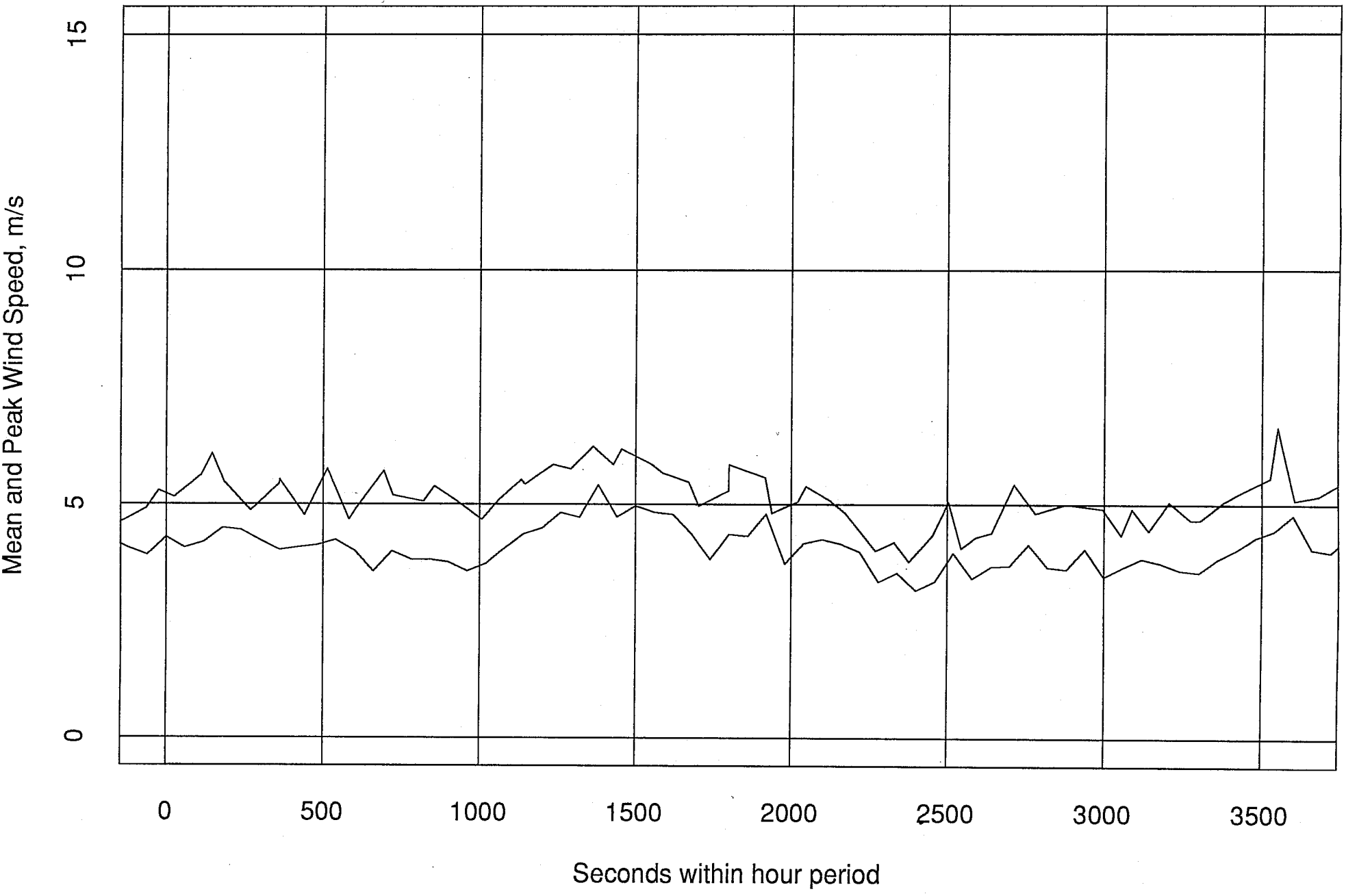




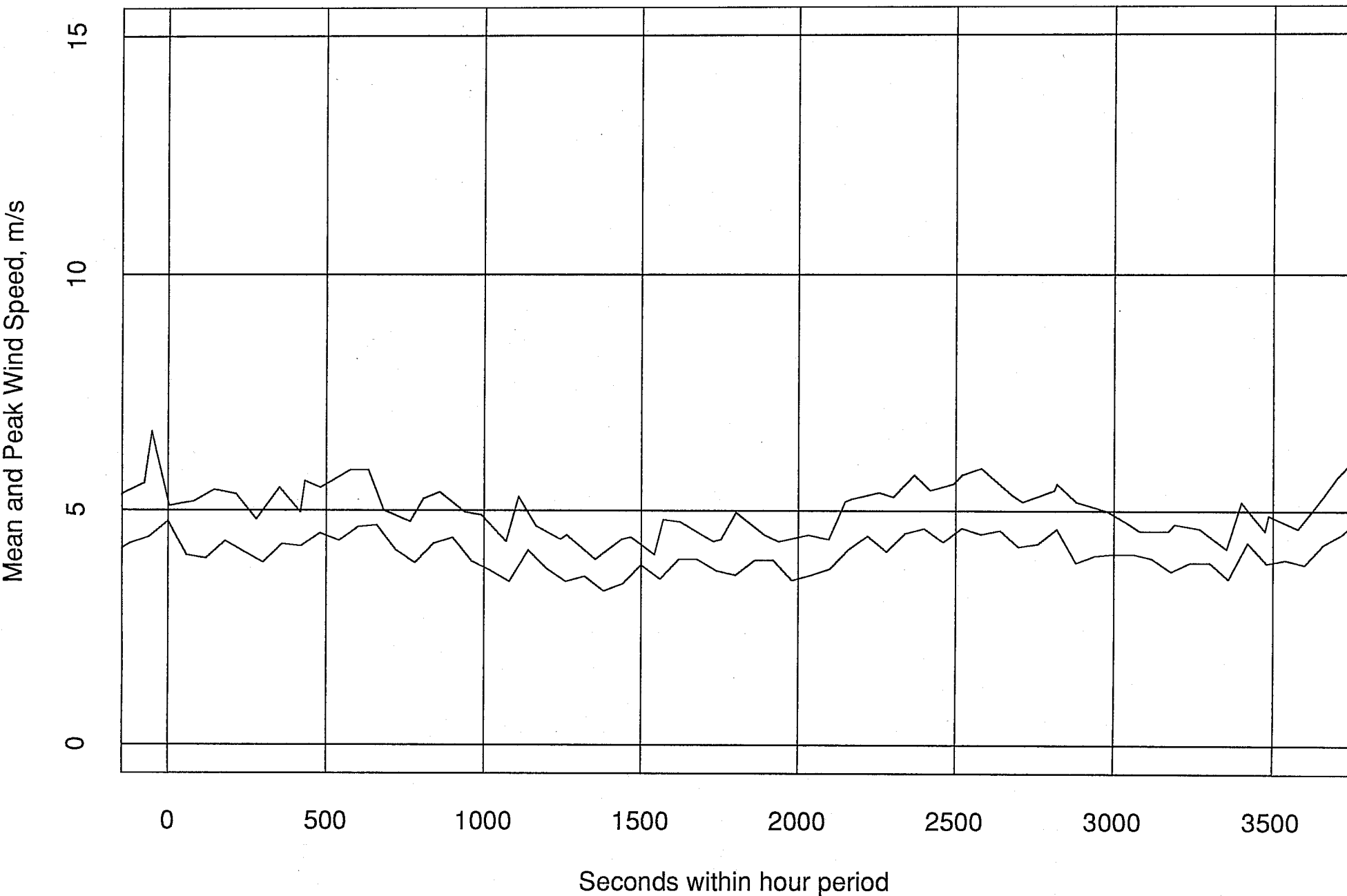
Mean and Peak Wind Speeds, Day 237 Hour 22:00 PDT LIGO-C950581-00-0



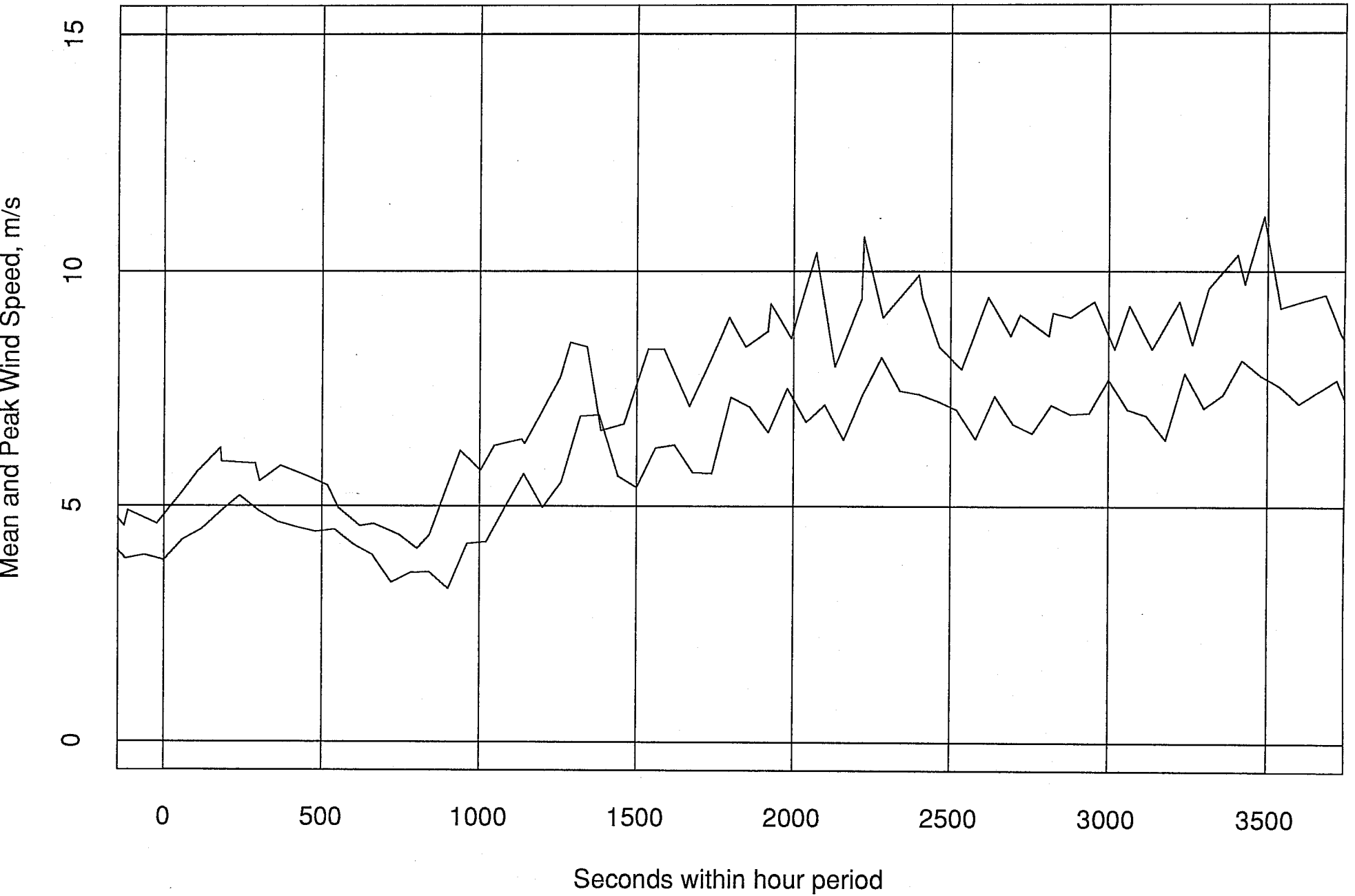
Mean and Peak Wind Speeds, Day 237 Hour 23:00 PDT LIGO-C950581-00-0



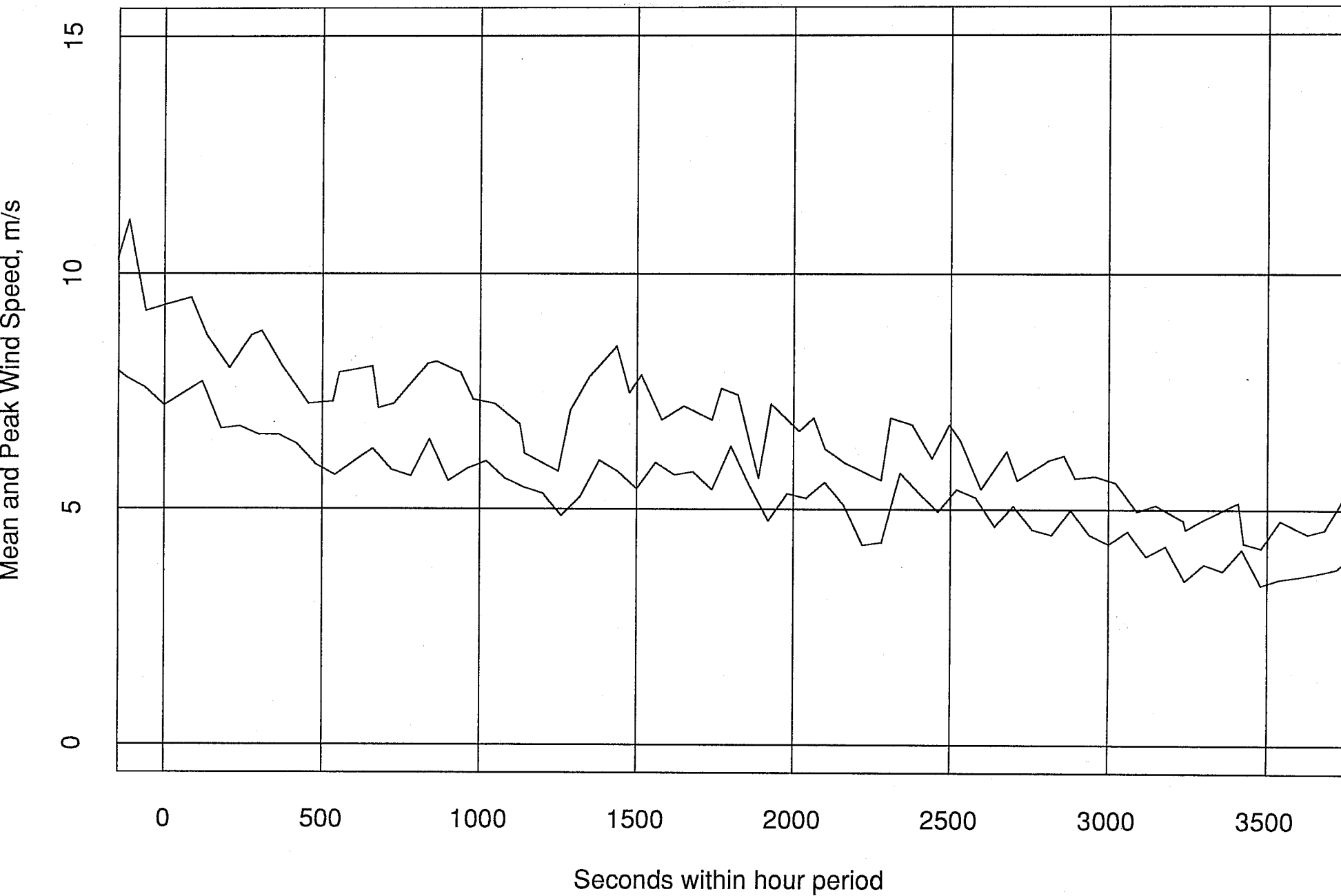
Mean and Peak Wind Speeds, Day 238 Hour 00:00 PDT LIGO-C950581-00-0



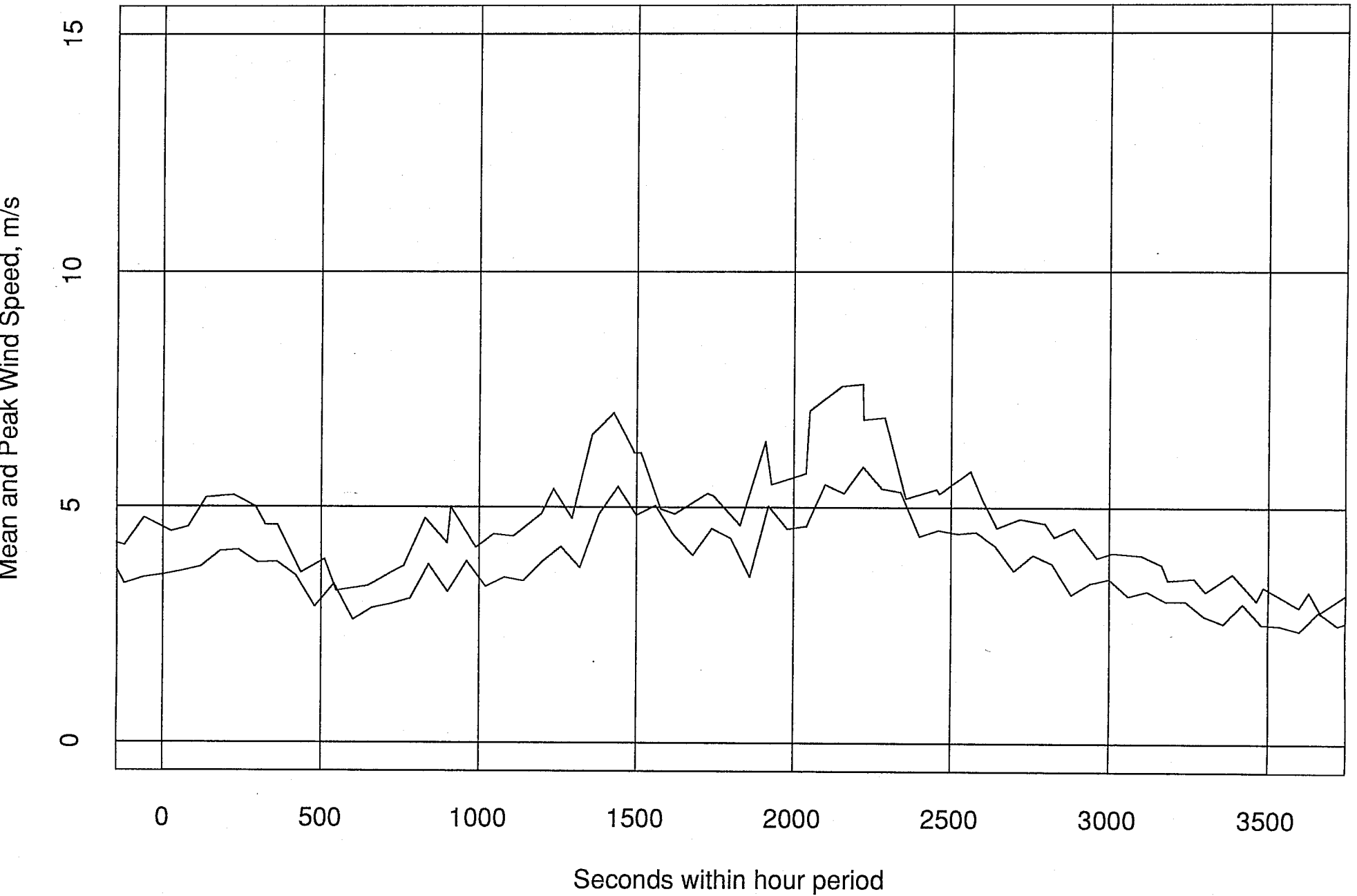
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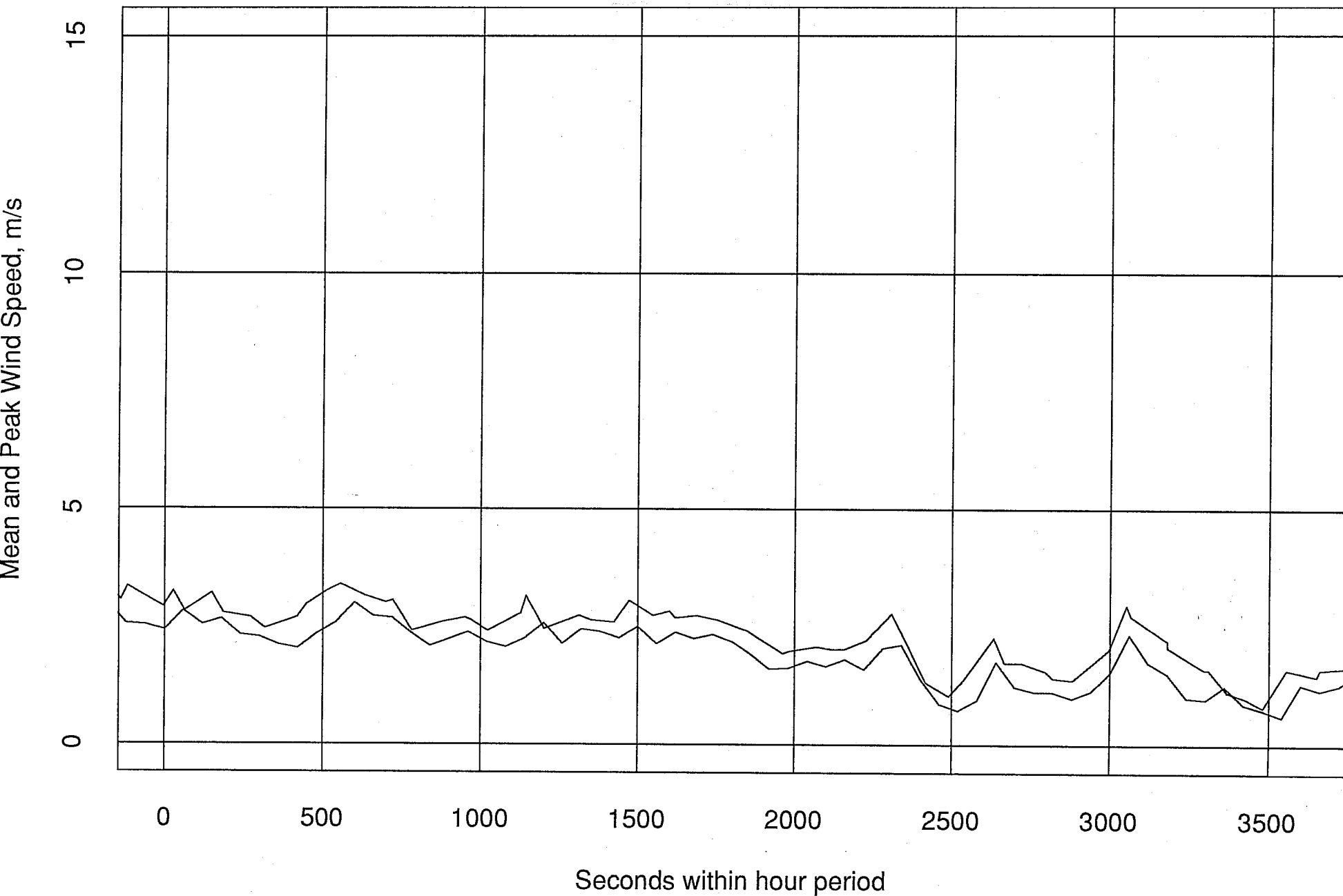
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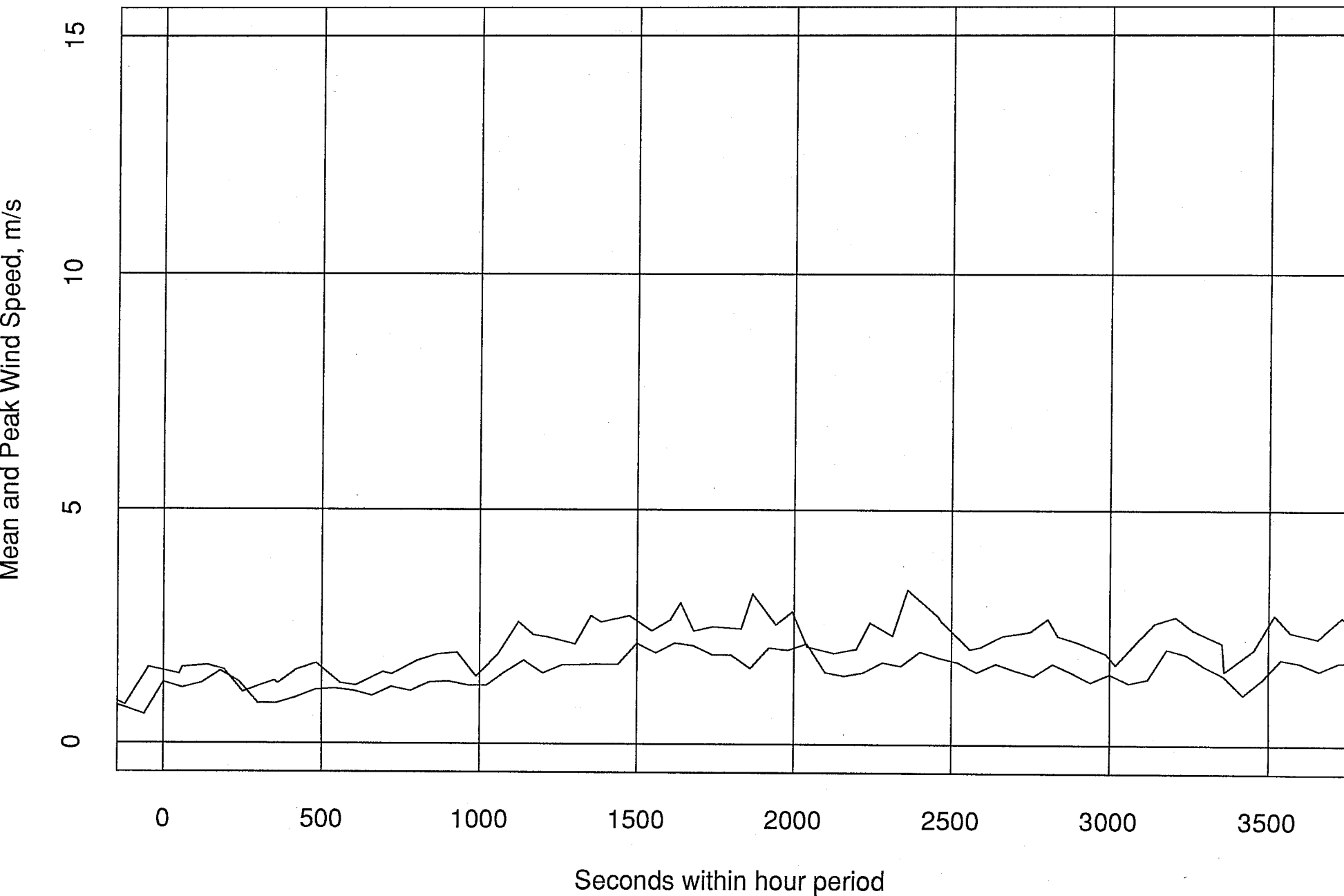
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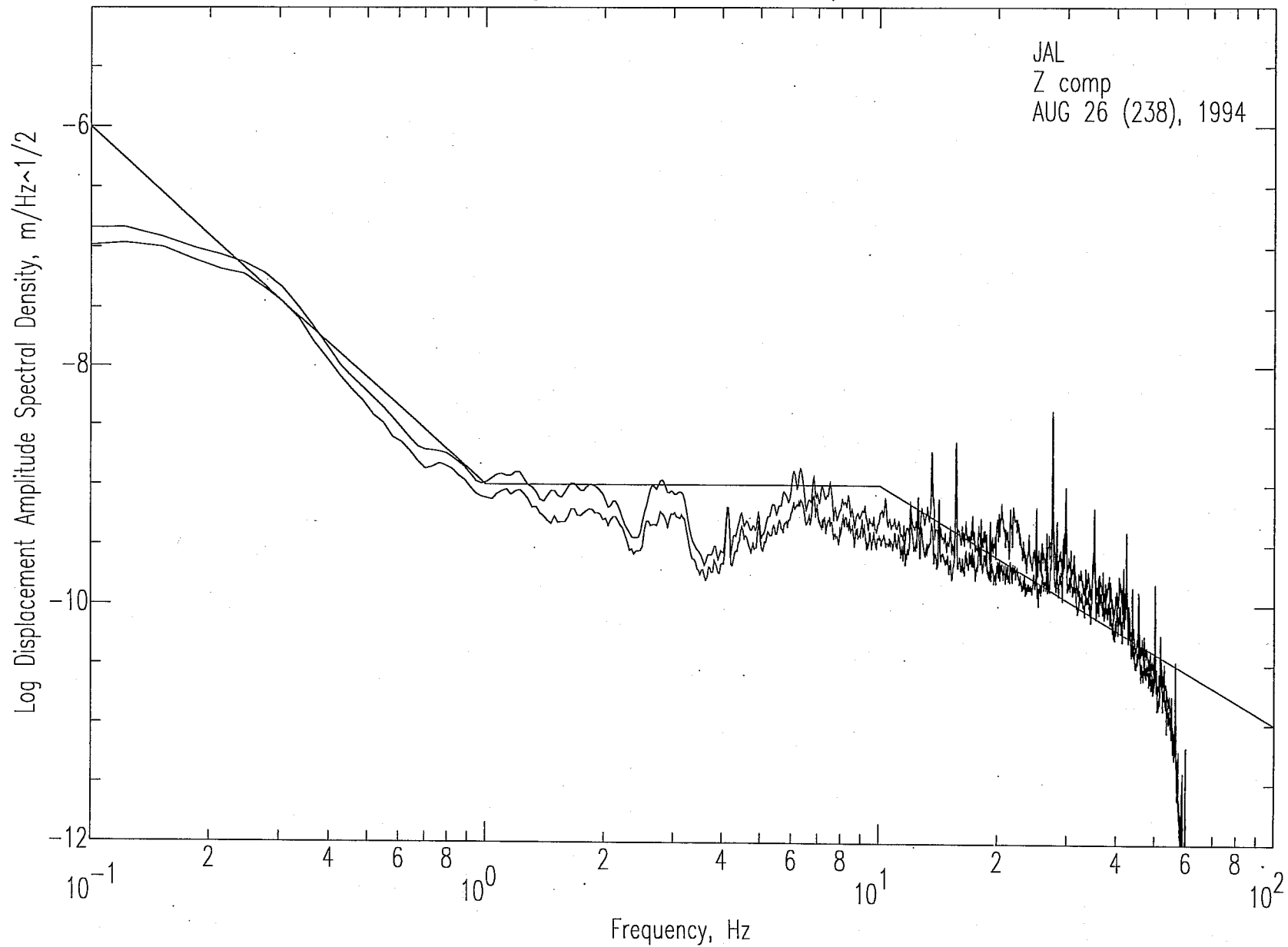
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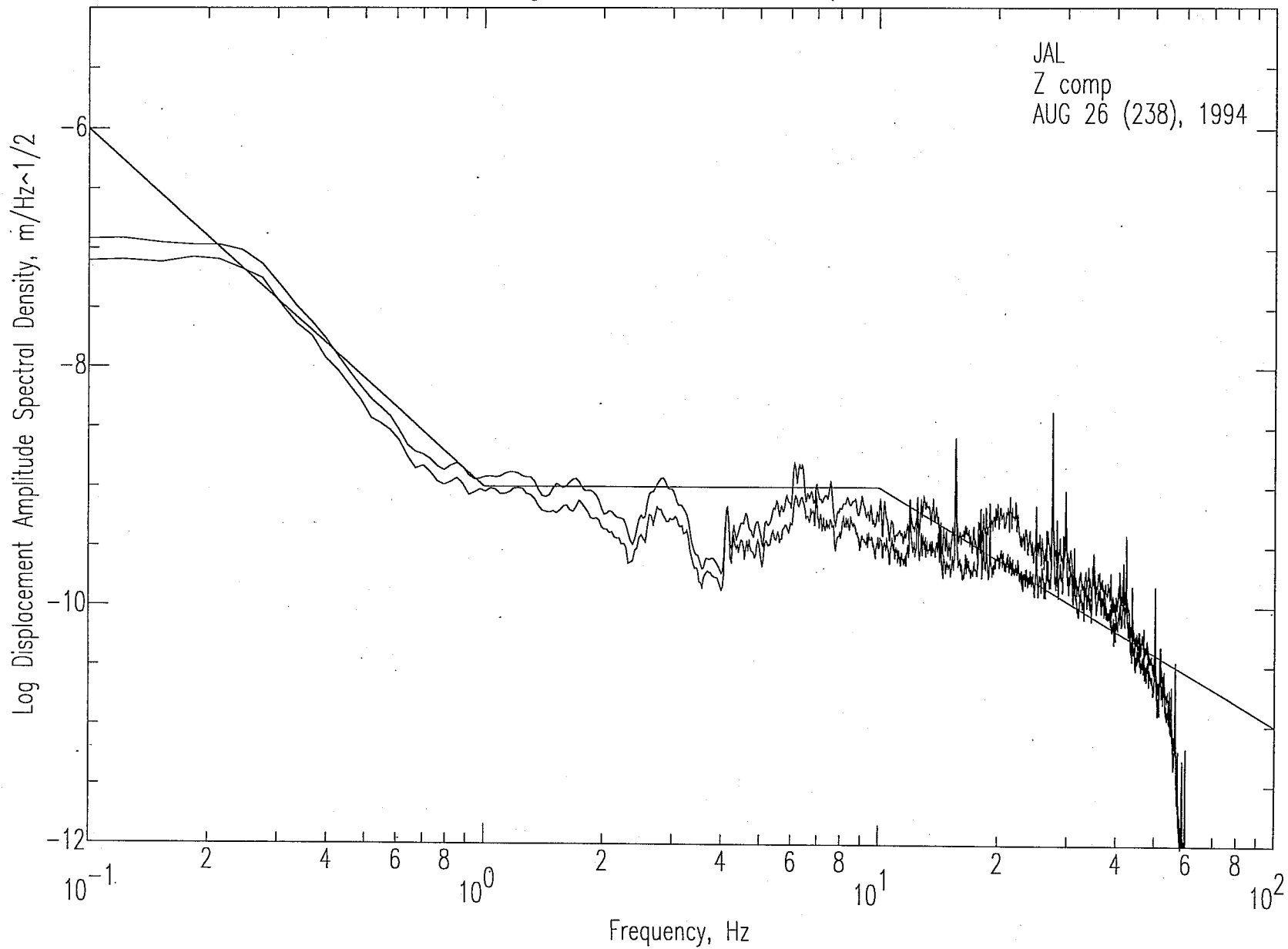
Mean and Peak Wind Speeds, Day 238 Hour 05:00 PDT LIGO-C950581-00-0



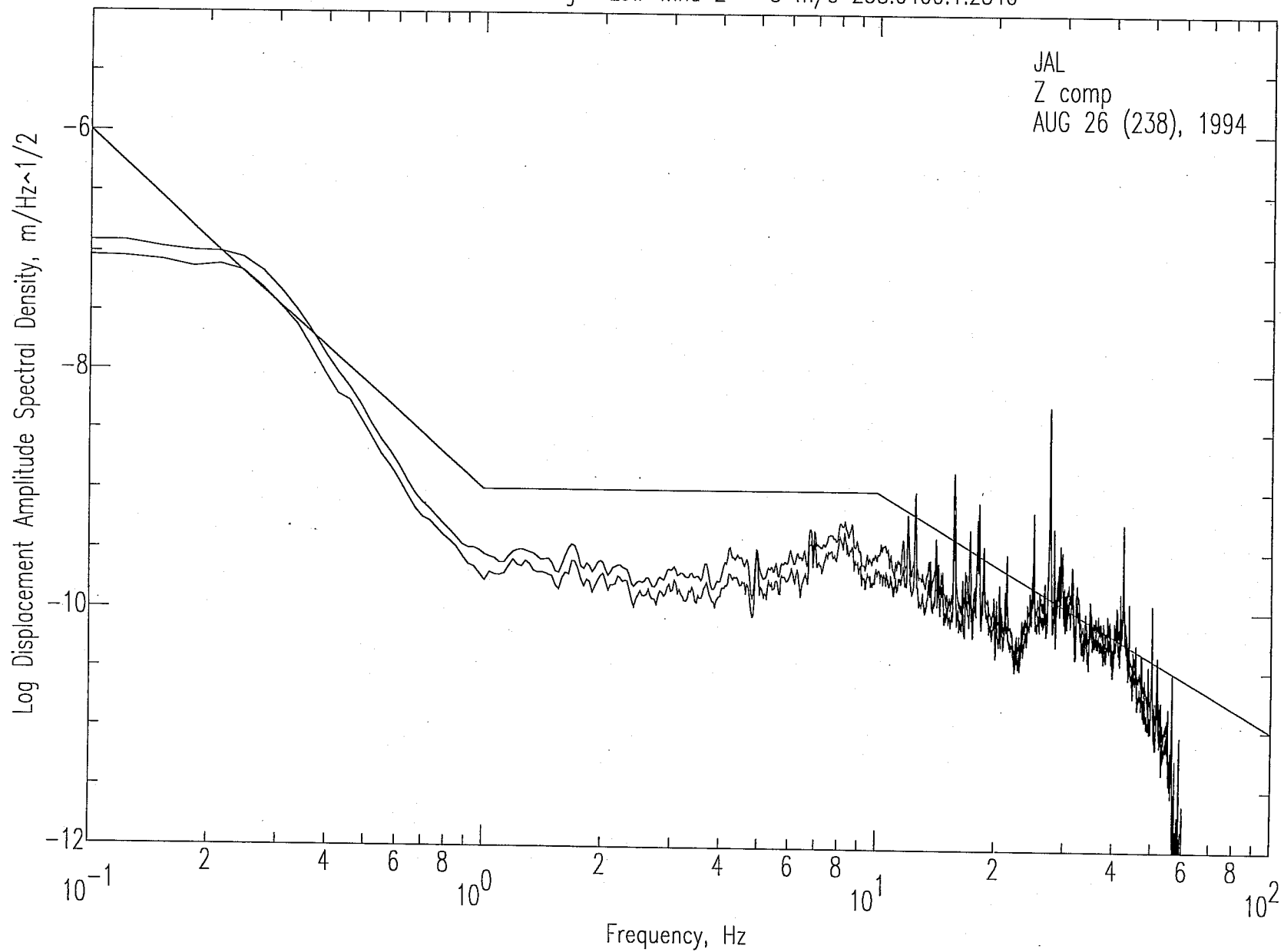
Moses Lake JAL Hangar Moderate Wind 7 - 8 m/s 238.0100.1.2000



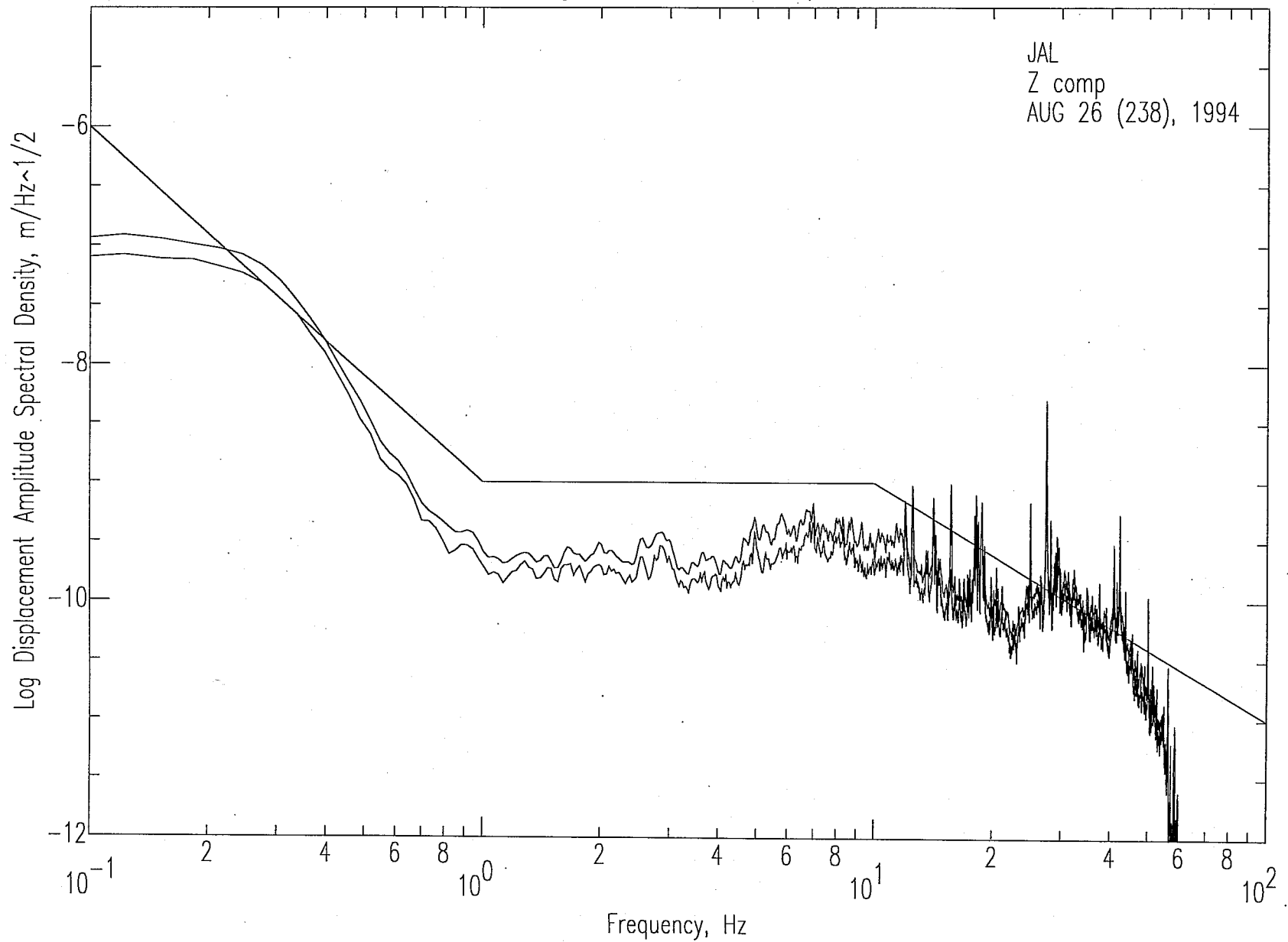
Moses Lake JAL Hangar Moderate Wind 7 - 8 m/s 238.0100.1.2640



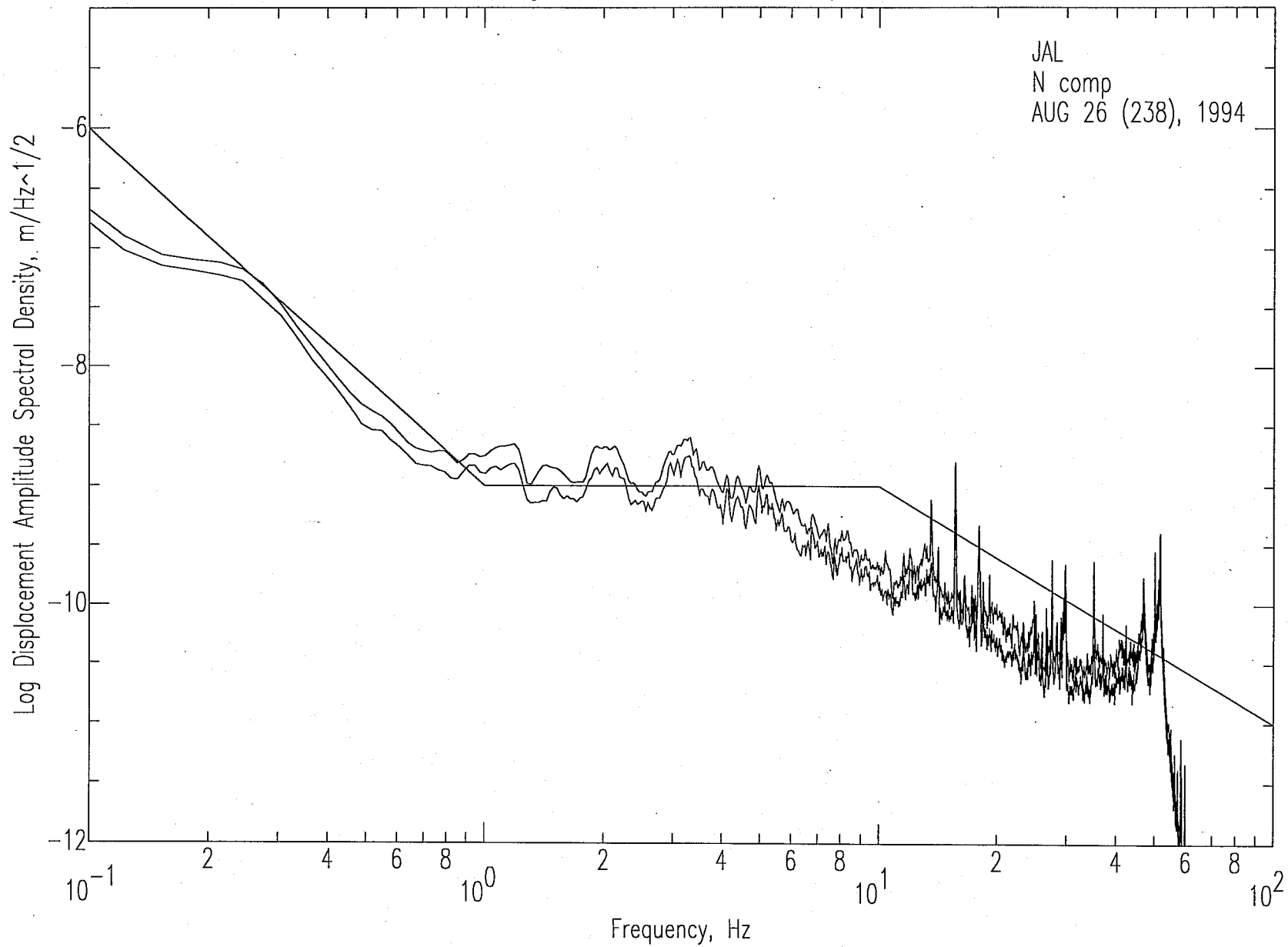
Moses Lake JAL Hangar Low Wind 2 - 3 m/s 238.0400.1.2540



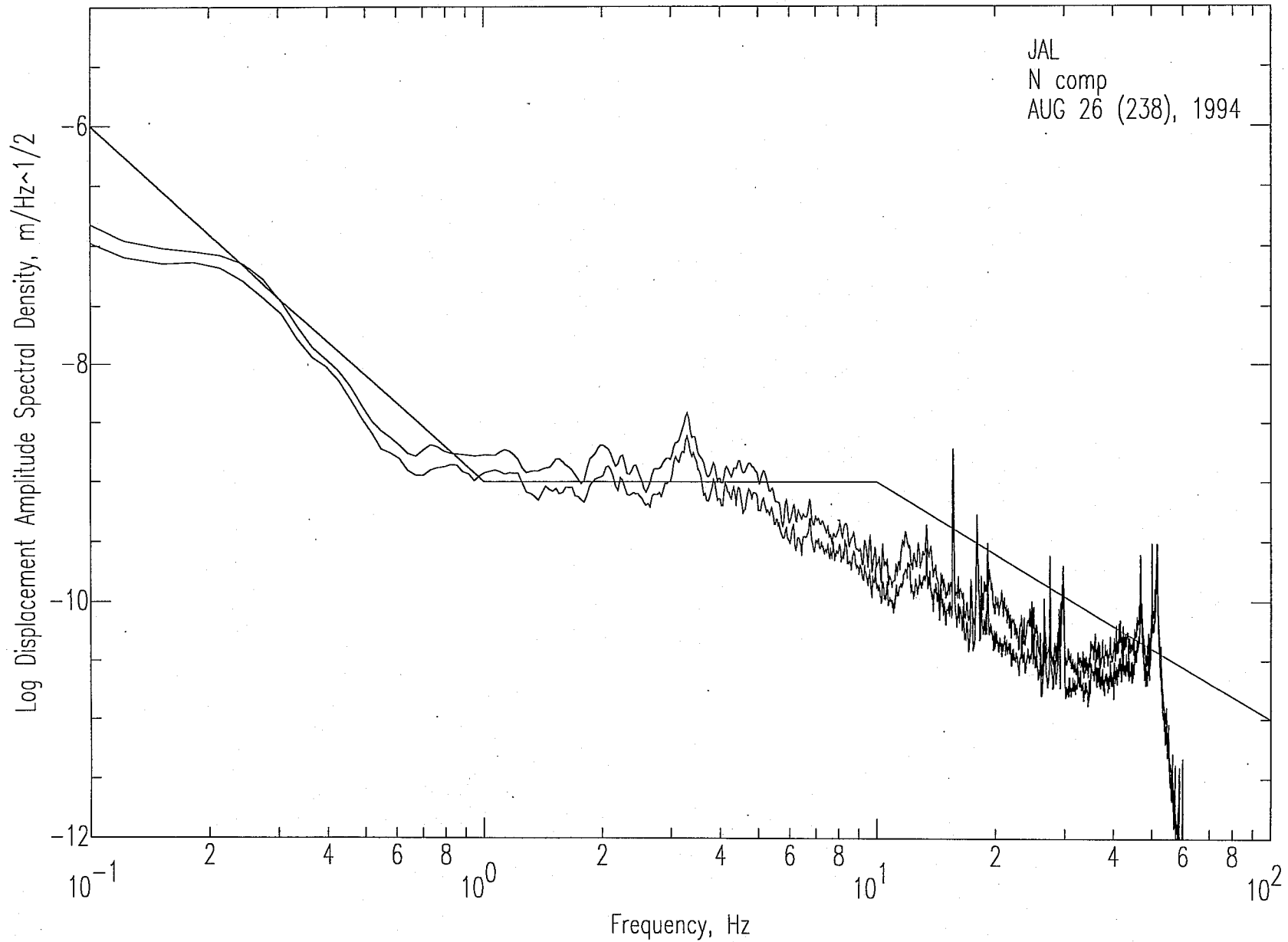
Moses Lake JAL Hangar Low Wind 2 - 3 m/s 238.0400.1.3140



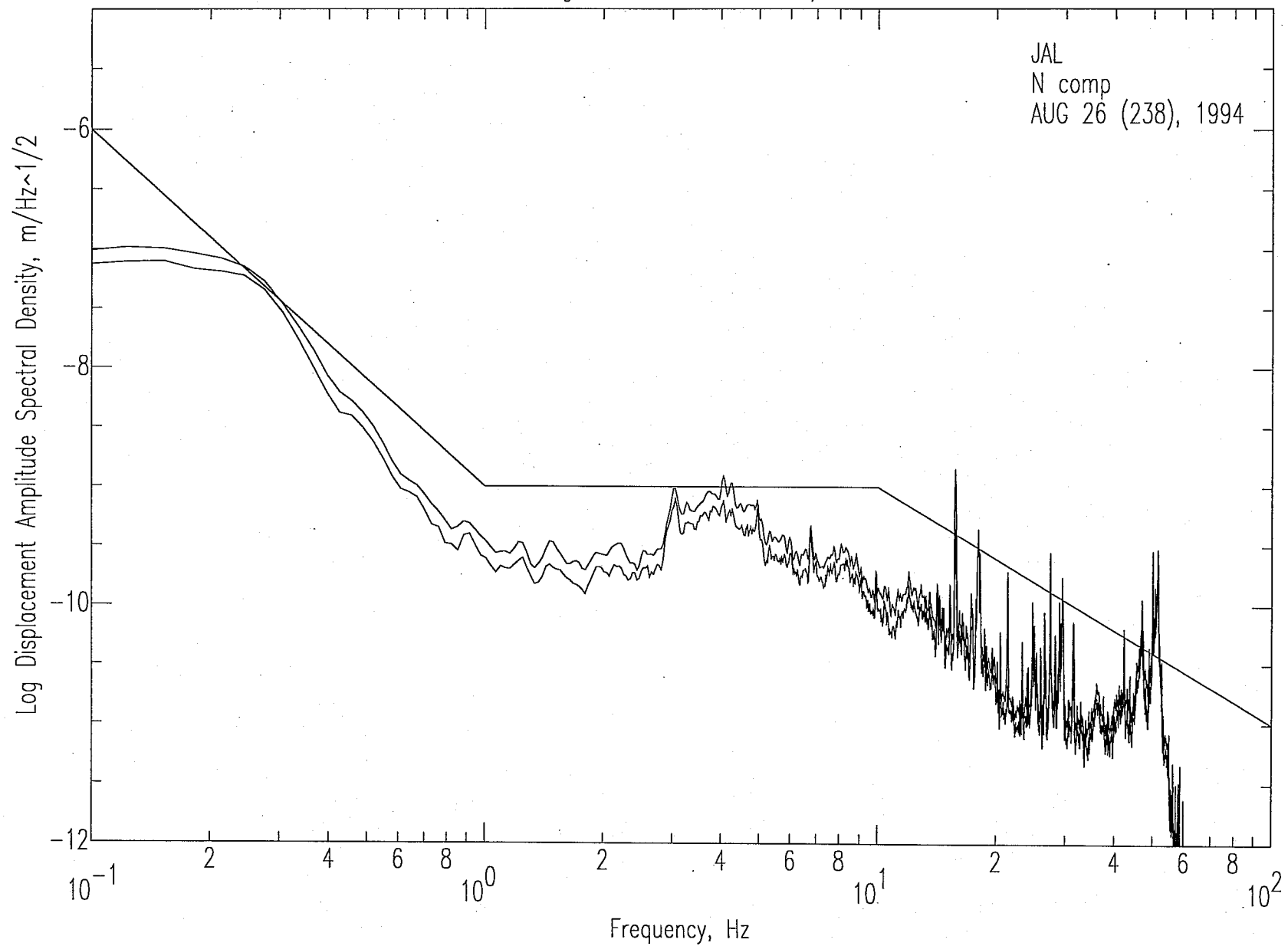
Moses Lake JAL Hangar Moderate Wind 7 - 8 m/s 238.0100.2.2000



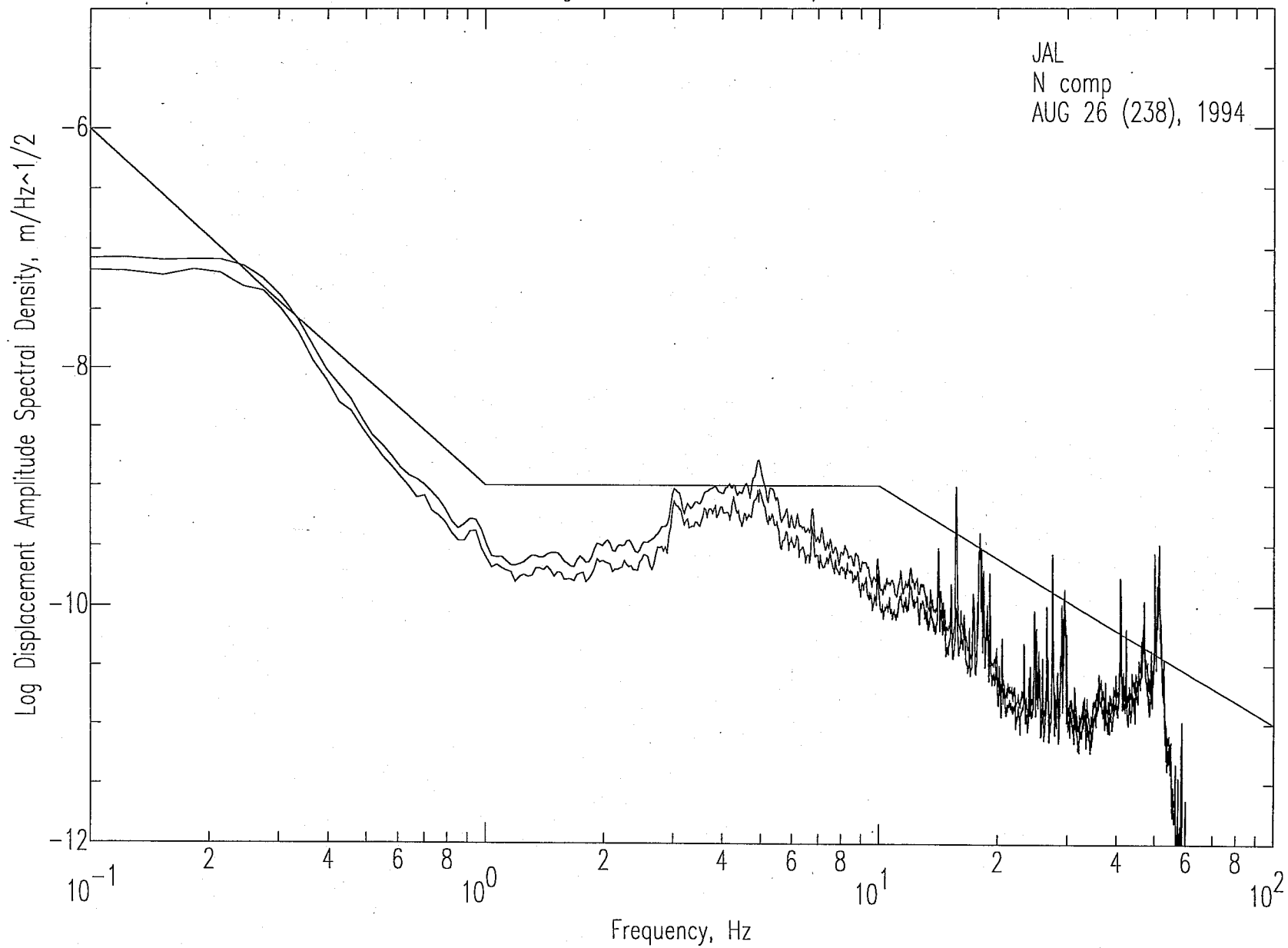
Moses Lake JAL Hangar Moderate Wind 7 - 8 m/s 238.0100.2.2640



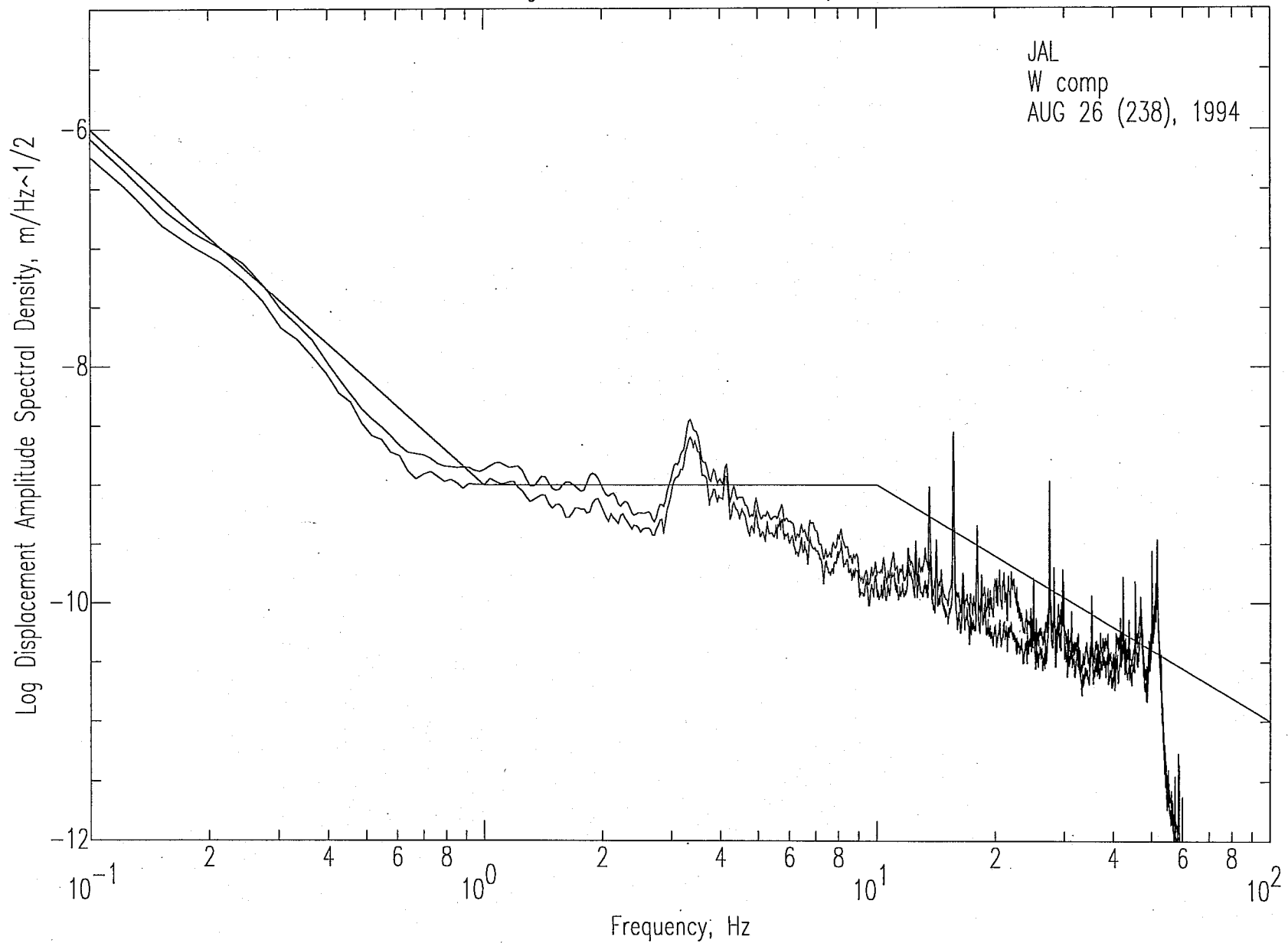
Moses Lake JAL Hangar Low Wind 2 - 3 m/s 238.0400.2.2540



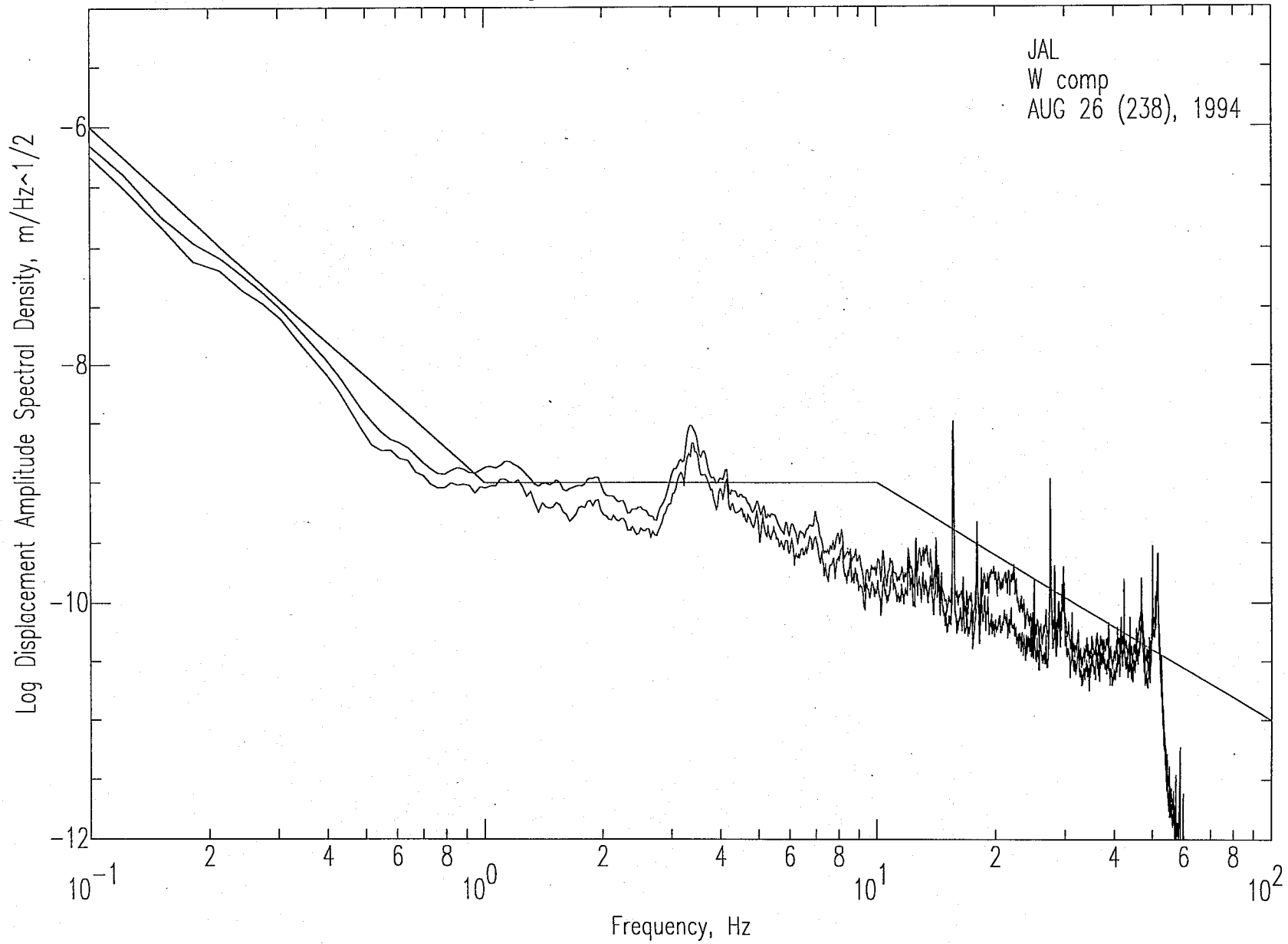
Moses Lake JAL Hangar Low Wind 2 - 3 m/s 238.0400.2.3140



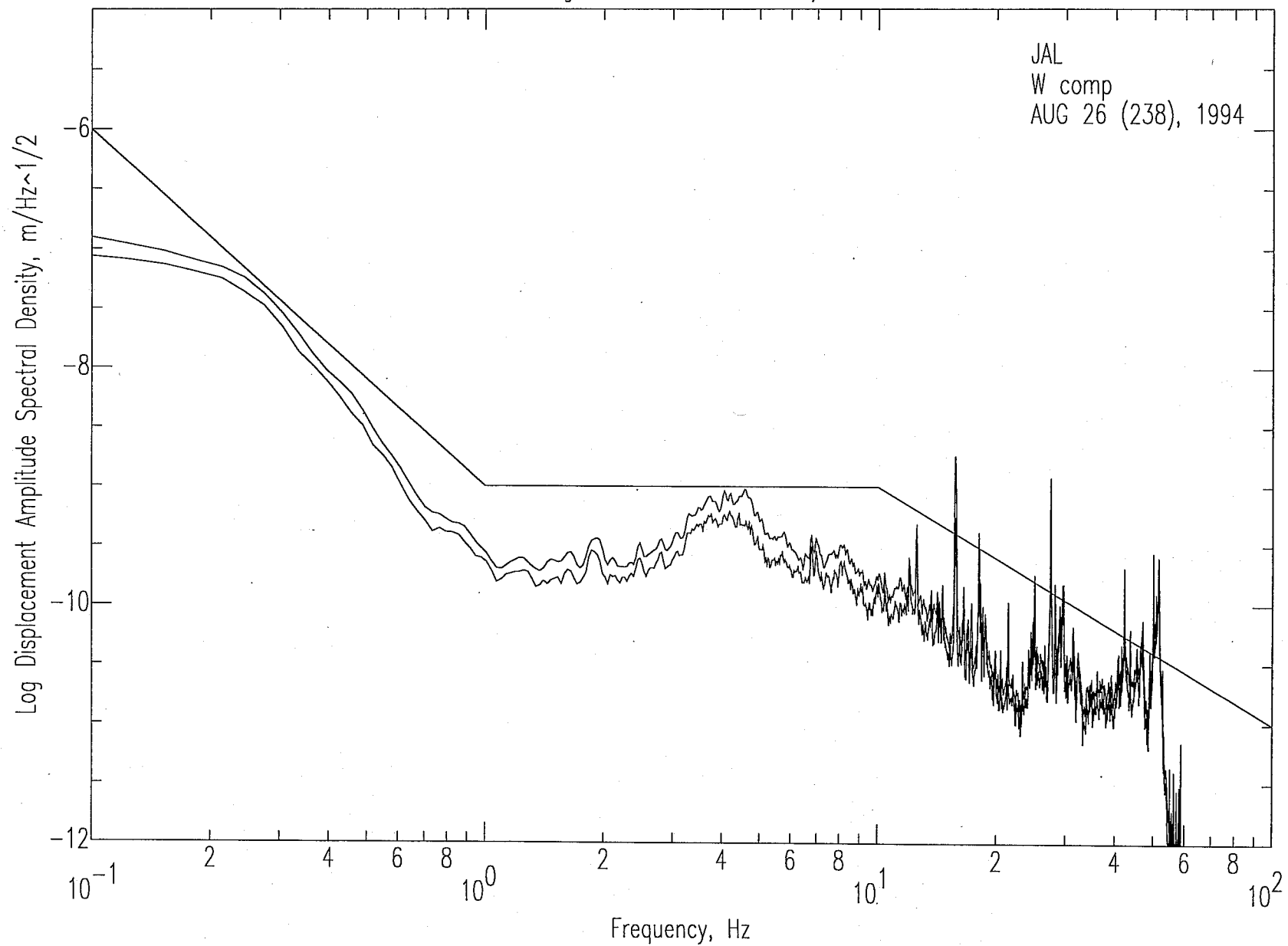
Moses Lake JAL Hangar Moderate Wind 7 - 8 m/s 238.0100.3.2000



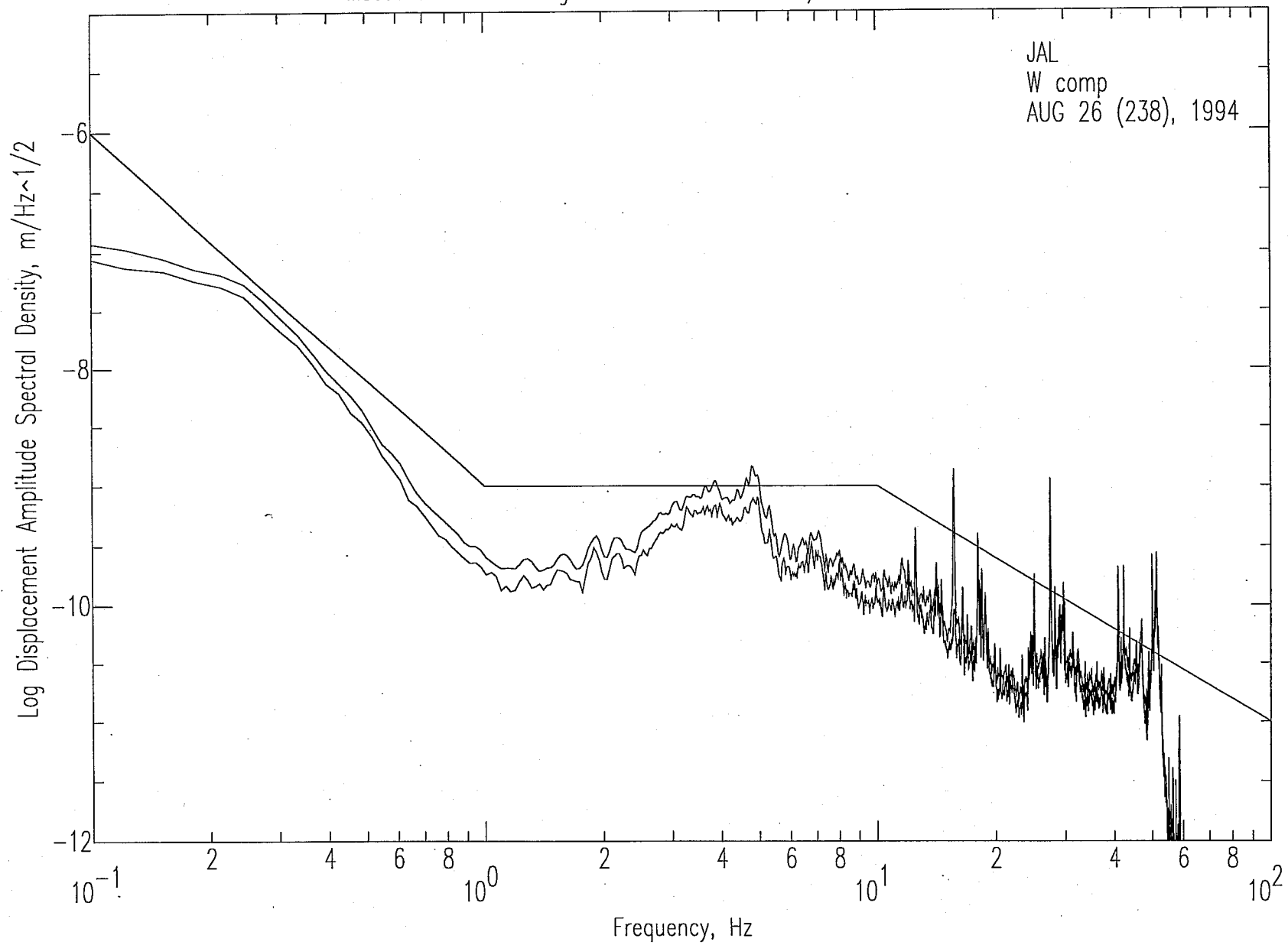
Moses Lake JAL Hangar Moderate Wind 7 - 8 m/s 238.0100.3.2640



Moses Lake JAL Hangar Low Wind 2 - 3 m/s 238.0400.3.2540



Moses Lake JAL Hangar Low Wind 2 - 3 m/s 238.0400.3.3140



**Ambient Ground Vibration Measurements
at the Hanford, Washington LIGO Site**

Appendix J

LIGO Site Video Tape Log

LIGO Site Annotation of Video Taping**November 18, 1994****Tape #1****0:00.0 to 0:21.19****GMT Day 322:18:34 to 322:18:57**

- 10:34 Begin taping construction activity at North leg of LIGO (taping from east of leg, facing west).
- 10:36 Dump truck (dt) with pup is dumping load of gravel (1st, pup)
- 10:37 Same dt unloading main compartment
- 10:38 Front-end loader (fel) traveling northbound (nb) to dump gravel load into hopper
- 10:42 Very large water truck (tape count ~00:06.15 seconds) approaches then turns around and leaves, southbound (sb)
- 10:44 fel approaching
- 10:45 dt stops in front of camera, backs up and dumps gravel from pup
- 10:46 fel is passing, nb
- 10:46 dt unloads gravel from main compartment (truck flap is banging around; audible)
- 10:47 Water truck leaves with dt
- 10:47 fel travels past, sb, stops to scoop up gravel
- 10:48 fel travels nb, loaded

NOTE: During the taping, the back-hoe (bh) is continuously dumping gravel along road cut.

- 10:49 fel loader (empty) passes and scoops a load of gravel
- 10:50 (off the screen) the bh is moving
- 10:51 Behind, a dt is dumping load onto gravel pile
- 10:51 Another dt approaches from the south (travelling northbound)
- 10:52 1st dt is dumping main load (audible "booms" from flap)
- 10:53 1st dt leaves. 2nd dt dumps gravel from main compartment
- 10:54 fel (empty) passes, sb, and scoops up gravel. Turns around and moves nb
- 10:56 Empty fel and small, tool truck pass. fel scoops.
- 10:57 fel travels nb

End of tape 1.

LIGO Site Annotation of Video Taping**November 21, 1994****Tape #2 (tape count 0:00.0 to 0:46.41)****300 M from construction activity at northernmost portion of North leg****GMT Day 325:23:45.33 to 326:00:38.0**

- 3:45.33 Northernmost portion of North LIGO leg (heavy equipment covering exposed road cut with gravels)
- 3:46 Empty dump truck (dt) and pup travelling southbound (sb) (~30mph?)
- 3:49 Full dt and pup travelling northbound (nb)

NOTE: Taping stopped to change batteries (3:49 - 3:54). The second dt and pup passed during this interval. A third dt's and pups also passed n.b. during this interval. By 3:54, there were 3 dt's and pups at the construction site.

- 3:54 Empty dt and pup travelling sb
- 3:55 Front-end loader (fel) travelling down off of rough (empty)
- 3:55.58 Empty dt travelling sb
- 3:56 Full fel ascending terrain
- 3:58 Empty dt, travelling southbound
- 3:59 Empty fel coming down off hill (side of slope)
- 4:00 fel scooping up gravel
- 4:00-02 fel travelling up hill (rough terrain)
- 4:02 fel dumps load onto cut
- 4:03 fel begins descent off of hill
- 4:04.37 fel scoops up gravel from pile

Note: During this entire time, there is a back-hoe and fel scooping up and dropping gravels onto road cut.

- 4:07 fel dumps gravel load onto cut
- 4:14 Approximately 5 miles southwest of site, a helicopter is flying overhead (microphone may have picked this up)
- 4:15 Light truck approaching, northbound
- 4:16 Light truck passes (~4:16.45), northbound
- 4:18.38 Back hoe scooping out gravels
- 4:21.11 fel ascending hill
- 4:21.25 Back hoe scooping out of hopper
- 4:21.57 Back hoe dropping gravel onto cut
- 4:22.10 fel dumping gravel into hopper
- 4:22.42 Back hoe scooping gravel out of hopper
- 4:22.54/55 Back hoe dropping gravel onto road cut
- 4:23.11 Plane flying overhead
- 4:23.47 fel load gravel into hopper
- 4:24.02 Back hoe dumps gravel onto cut

4:24.48/50 fel scooping gravel from pile
4:25.08 Small/light truck approaching, northbound
4:25.22 Small/light truck passes by
4:26.25 Helicopter flying in southwest sky

NOTE: this construction activity has continued to occur during entire tape

4:29.07 Back hoe dumps onto cut
4:29.23/25 fel scoops up gravel
4:29.40 fel dump load into hopper
4:29.47 Back hoe scoop out of hopper
4:30.01 Back hoe dump load onto cut
4:30.28 Back hoe scooping gravel out of hopper, audible "boom" from truck flap
4:32.08 Back hoe scooping gravel out of hopper
4:32.18 Back hoe dump onto road cut
4:32.46 fel ascending up hill
4:33.17 Back hoe scooping gravel out of hopper
4:34.03 Back hoe scooping gravel out of hopper
4:34.12 Back hoe dropping gravel onto cut / fel dumping into hopper
4:35.19 Back hoe scooping gravel
4:35.31 Back hoe dropping gravel
4:35.38 Small jet airplane flying overhead
4:36.24 Small truck drives by, southbound
4:37.09 2nd small truck drives by, southbound
4:38 Stopped video recorder

End of tape 2.

LIGO Site Annotation of Video Taping**November 28, 1994****Tape #3 (tape count 0:00.00 to 0:36.54)****Vertex Weather Station (Seismometer at North end, 4km distant)****GMT Day 332:22:09 to 332:22:45**

- 2:09 Videotape dictation begins
- NOTE: West leg activity is occurring 1.4 miles west of ligo vertex. A scraper, grater, front-end loader (fel), water truck, and vibratory roller are surfacing and laying gravel out onto road cuts.
- 2:11 West leg vibratory roller is travelling eastbound, approaching vertex area water truck passed vertex, westbound
- 2:12 A dump truck (dt) full of gravel arrives at ligo, northbound from Route 10 ddt pup unloaded; fel scooping up gravel
- NOTE: Activity on screen is at southernmost portion of north leg (nearly at vertex). The dt is bring in gravel, dumping it into a pile, the back hoe (bh) then scoops it up and dumps it onto the road cut.
- 2:13.51/55 Same dt unloading gravel from main compartment
- 2:14 bh dropping gravel onto cut
- 2:15.07 fel scooping gravel
- 2:15.24 Empty dt driving off site
- 2:16 Full dt with pup arrives
fel scooping
- NOTE: two fels are working now; there are very high winds
- 2:17 fel and back hoe dropping gravel onto road cut
dt unloading pup gravel
2nd loaded dt arrived
- 2:18 1st dt dumps gravel from main road
- 2:19 1st dt leaving, empty
- 2:21 2nd dt dumps pup; dumps main load
- 2:22 Empty dt drives away and heads to west leg
- 2:23 Normal activity continues (bh and 2 fels scooping and dumping)
- 2:25 Full dt arriving, heads down west leg, and a medium truck follows
- 2:28 bh smoothing out/scraping gravel over cut, as a fel continues to lay gravel onto cut
- 2:29 Empty dt passes vertex weather station site, leaves site
One of the fel drove away with the hopper attached, rolling behind
- 2:31 bh is driving away from road cut activity
- 2:32 Both bh and fel with hopper are moving away from road cut activity
As seen in video, the vibratory roller is still working on west leg road

NOTE: the 2nd fel is still scooping gravel from pile and dropping onto cut

2:34 Empty dt passes vertex site from west leg to Route 10
 2:35 Light truck passes, leading towards Route 10
 2:39 fel stops moving
 2:41 fel moving again
 fel dumps load of gravel
 2:43 fel is scooping up gravel
 2:44 fel is dumping load of gravel
 2:45 Taping is stopped

LIGO Site Annotation of Video Taping

November 29, 1994

Tape #3 (tape count 0:36.55 to 1:07.53)

North end of North leg (very windy, 10-15mph)

GMT Day 333:23:50 to 334:00:04.21

3:50 Begin taping southbound traffic on Route 4 (south)
 A few vehicles are passing intermittently
 3:54.15 Traffic flow is increasing
 3:57 Gusts of wind
 4:00 Zooming camera in on the traffic
 4:01 Gusts of wind causing camera to shake
 4:04 Traffic is pretty steady, about one car every 2 seconds
 4:17.57 "Still pretty windy," Alan R.
 4:20 "Continuous stream of traffic..." Alan R.
 Wind effect on seismometer??
 4:21 Stop video recording

LIGO Site Annotation of Video Taping**December 1, 1994****Tape #3 (tape count not determined)****North end of North leg****GMT Day 335:18:57 to 335:19:05**

10:57 Vibrating roller at north leg site

NOTE: "windy"

11:01-:03 Vibrating roller moving south towards a loader and a grader working at next turnout south of north end station

11:03-:04 Vibrating roller has moved about 1/2 distance to turnout site

11:04 Video of traffic on Route 4 south

11:05 Video recorder stopped

LIGO Site Annotation of Video Taping**December 4, 1994****Tape #3 (tape count not determined)****At Highway 240 milepost 17 (6km north of Highway 10)**

12:30 Begin video taping

12:30 Vehicle passes northbound; station wagon

12:32 Car, sb

12:33 Van northbound and car southbound

12:34 Car southbound

12:32:20 2 cars northbound

12:35 Airplane noise - propeller plane for @ 20 seconds (hearing some wind noise too)

12:37 Car passes southbound

12:38 Pickup northbound (tarp flapping) and loud pickup southbound

12:39 3 cars passing southbound

12:42 Van passing southbound

12:43/12:44 3 vehicles pass sb, one nb

12:45/12:46 Two cars sb

12:46:20 Another car sb

12:48/12:49 2 cars sb; pickup northbound

12:50 Van northbound and car southbound (12:51 passed site)

12:52 Pickup northbound

12:53 3 cars southbound

12:55 Pickup southbound

12:56 2 cars nb and 1 car sb

12:57 2 cars nb and car sb

12:58 Car nb

1:00 3 cars sb (together) (1101 pass site)
1:02 Car nb
1:03 Pickup sb
1:05 1 car nb; 1 car sb
1:06 1 car nb
1:08 1 car sb
1:08:40 1 car sb

End of tape 3

LIGO Site Annotation of Video Tape**November 21, 1994****Tape #4 (tape count 0:00.0 to 0:18.14)****North leg (midway)**

NOTE: This portion of the tape is useless. The seismometer wasn't operating yet.

10:24 Back hoe (bh) scooping/dropping gravel onto the road cut
 dump truck (dt) with pup approaching activity from the south
 Light truck (Alan/Donna) driving off road to turn on seismometer
 Front-end load (fel) scooping/dumping gravel into hopper
 10:26 dt pup is dumped onto gravel pile

(I stopped annotating this tape because the seismometer wasn't operating)

LIGO Site Annotation of Video Taping**December 11, 1994****Tape #4 (tape count 0:18.15 to 0:46.00)****Vertex Weather Station (taping of Route 10 truck passes)****GMT Day 345:21:21.22 to 345:21:50**

NOTE: Arrived at site 12:52

1:21.22 Begin taping, Patrol car passes by LIGO entrance
 1:22 Small plane flying overhead (perhaps a Cessna)
 1:23 Tape was turned off
 1:25 Tape turned back on
 1:27/28 I got into the Suburban, started it, and drove off-road onto the LIGO gravel
 road, and then onto Route 10 to make passes
 1:28 Truck is up onto the LIGO site gravel road
 1:29 Can now see the Suburban truck in the screen
 Driving off-road to make passes
 Now driving on Route 10, northbound
 1:31 Suburban makes its #1 pass, travelling southbound at 55mph
 1:33 Suburban makes its #2 pass, travelling northbound at 55mph
 1:34 A car passes, travelling southbound
 1:35 Suburban makes its #3 pass, travelling southbound at 55mph
 1:36 Suburban makes its #4 pass, travelling northbound at 55mph
 1:38 Suburban makes its #5 pass, travelling southbound at 55mph
 1:39 From playing back the videotape, it sounds as though a jet airplane was passing
 overhead
 1:40 Suburban makes its #6 pass, travelling northbound at 65mph
 1:42 Suburban makes its #7 pass, travelling southbound at 65mph
 1:43 Suburban makes its #8 pass, travelling northbound at 65mph

- 1:45 Suburban makes its #9 pass, travelling southbound at 65mph
- 1:46 A van passes, travelling northbound
- 1:47 Travelling off-road (for @7 seconds), and then back onto LIGO gravel road
- 1:48 An amplified male voice can be heard on the video tape (probably projected from FFTF)
- 1:49 Suburban approaching the vertex weather station
- 1:50 Tape is turned off

NOTE: Departed site 1:54

End of tape #4

LIGO Site Annotation of Video Taping**December 13, 1994****Tape #5 (tape count 0:00.00 to 1:27.08)****Route 10 Traffic as taped from Vertex weather station****Wind is light, @3mph****GMT Day 347:22:26 to 348:00:33**

2:26 Begin taping. Taking a look around the site
 2:27 Vehicular traffic on Route 10 can be heard
 2:30 Stop taping
 2:38 Recording traffic on Route 10 again
 2:38.55 Vehicle passes LIGO vertex site
 2:39 Northbound vehicle passes
 2:40 "Can hear a low-frequency hum..." Alan R. (coming from WPPSS Plant)
 2:41 "Jen is moving around a bit"
 2:42.44 Light truck passes southbound
 2:42 Light truck passes southbound
 2:43 Light truck passes southbound
 2:45.00 Car passes southbound
 2:45.59 Station wagon passes northbound
 2:46 WPPSS is more audible now
 2:46.55 Car passes southbound
 2:47.30 Station wagon passes southbound
 2:47 Plane flying overhead
 2:48.10 2 vehicles pass southbound
 2:48.50 Southbound car
 2:51 Northbound vehicle is suddenly audible
 2:52.22 This vehicle and another are passing, northbound
 2:52.30 Car passes, travelling north
 2:53.10 Car southbound
 2:54.00 Car southbound
 2:55.50 Car southbound
 2:56.00 Pick-up truck, southbound
 2:56.08 Small moving van, southbound
 2:56.36 Small car, southbound
 2:57.25 Step van, northbound
 Car, northbound (@10 seconds after)
 2:58 Megaphone (?) from FFTF
 2:59.35 Light, pick-up truck
 3:01.18 Northbound/southbound cars pass at same point
 3:01.44 Truck, southbound
 3:01.57 Pick-up truck, southbound
 3:02.22 Small van, southbound
 3:02.45 Van, southbound

3:03.23 Two pick-up trucks, southbound
 3:04 Jet aircraft is audible
 3:05.25 Car, southbound
 3:07.09 Car, southbound
 3:07.55 Car, northbound
 3:08.54 Pick-up truck southbound

NOTE: Cannot hear WPPSS plant now; wind direction has changed

3:09 Truck, northbound
 3:10.28 3 vehicles pass, southbound
 3:11.21 Car, southbound
 3:11.48 Car, southbound
 3:12.00 Jeep, southbound
 3:13 Stop taping, started truck engine for heat

NOTE: Truck engine running 3:13 to 3:43

3:43.03 Begin taping again. Flow of traffic has increased
 3:43 Cessna flying overhead; turned our truck off
 3:44.05 Cars passing, southbound
 3:45.15 Car passing, southbound
 3:45.20 Alan R. thinks he heard the sound of a "shot gun"
 3:45.33 3 vehicles pass, southbound
 3:45 One more car passes, southbound
 3:45.52 Car, southbound
 3:46.05 Pick-up truck, southbound; we got into the truck to warm up; the tape is running
 3:47 Airplane is audible on tape
 3:48 Several southbound vehicles pass
 3:51 2 clumps of traffic, southbound
 Traffic is sparse now
 3:56 Several cars passing, southbound
 3:57 Several cars in a row are passing, southbound
 4:00 Traffic flow is slowing increasing, southbound
 4:04 Clump of 4 cars pass, southbound

NOTE: vehicles are passing intermittently, southbound

4:05 Clump of 4 cars pass, southbound
 4:06 Fairly steady traffic flow of traffic (perhaps this is the peak of rush-hour traffic)
 4:11.15 Got out of truck/walked over to video camera
 "Pretty continuous traffic..." "Practically no wind...@1mph" Alan R.
 4:12.45 4 vehicles pass, southbound
 4:13.10 5 vehicles pass, southbound

4:14.10 2 vehicles pass, southbound
4:14.23 3 vehicles pass, southbound
4:14.40 2 vehicles pass, southbound
4:15.10 3 vehicles pass, southbound
4:15 Walking back to vehicle
4:18 Flow of traffic has been slowing increasing
4:19 Few cars passing, southbound
4:20 Wave of cars pass, southbound
4:23 It seems traffic flow has decreased somewhat
4:25 Wave of vehicles pass, southbound
4:27 Small wave of traffic passed, southbound
4:30 Video camera battery died!
4:33 Alan re-started the camera to announce our departure

End of tape 5