# Vibration measurements and strategics in analyzing pipe vibration and pipe support damages

A consideration of pipe vibration measurements due to good and bad experiences

# Dispsition

- Why pipe vibration measurements?
  - Standards
  - Damages
- What are we facing
- Recommendations

# Examples of evaluation criterias

## ANSI/ASME OM3-1982, procedure 1

$$V_{allow} = \frac{C_1 \cdot C_4 \cdot (0.8 \cdot S_a) \cdot 3.64 \cdot 10^5}{C_3 \cdot C_2 \cdot K_2}$$

$C_1$ Factor for mass distribution
$C_2$, $K_2$ Parameter for stress condition
$C_3$ Factor for pipe contents and insulation
$C_4$ Factor for restraints
$(0.8\ S_a)$ Fatigue limit

## Seligman & Guillou

OK < 12 mm/s RMS @ PWR feedwater lines

## Russian PTM 38.001-94

I) No danger,
II) Danger not probable
III) Improvement is req. and damage is possible

| | Frequency Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 20 | 30 | 40 | 50 | 60 |
| Area | Vibration Velocity in um | | | | | | | | | |
| I | 250 | 230 | 200 | 180 | 165 | 120 | 95 | 85 | 75 | 70 |
| II | 500 | 450 | 400 | 360 | 330 | 230 | 180 | 145 | 135 | 130 |
| III | 1250 | 1100 | 950 | 900 | 750 | 500 | 420 | 350 | 320 | 300 |

## Gamble & Tagart

OK < 0.5 mm for f < 10 Hz
OK < 0.25 mm for f < 10-40 Hz
Based on findings for
400 pipe systems

## VDI 2063

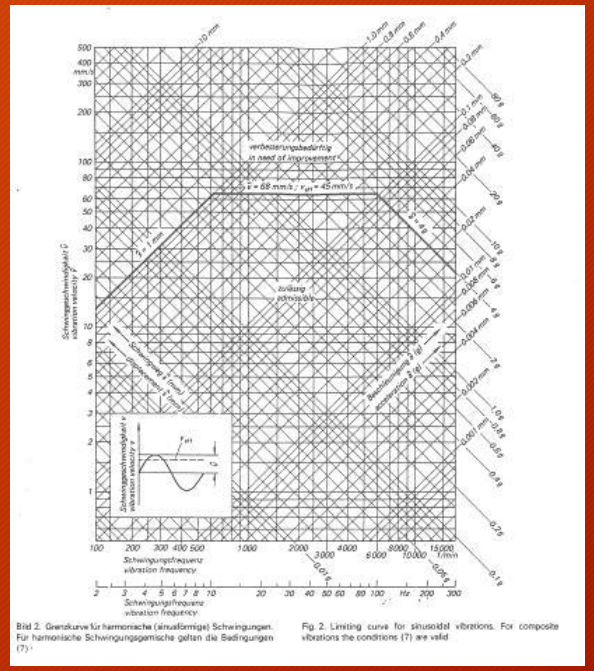
The requirements below should be fulfilled for 2-300 Hz
OK < 68 mm/s peak
OK < 1 mm peak
OK < 4 g peak
*+ VDI 3842: Vibration in piping systems ?*

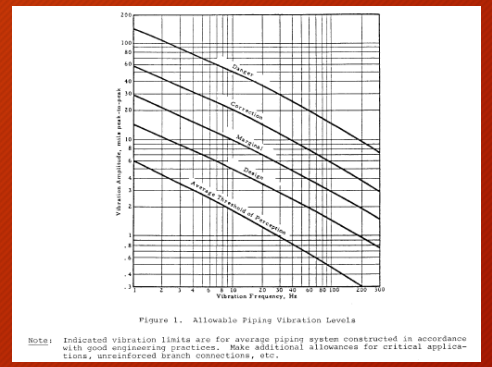
## Lloyds

OK < 35 mm/s peak
Danger >= 70 mm/s peak

## ABB

OK < 8 mm/s RMS
Danger >= 20 mm/s RMS



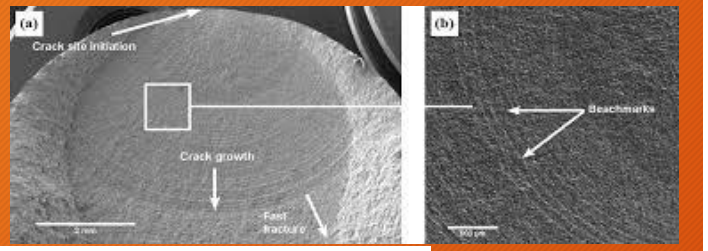


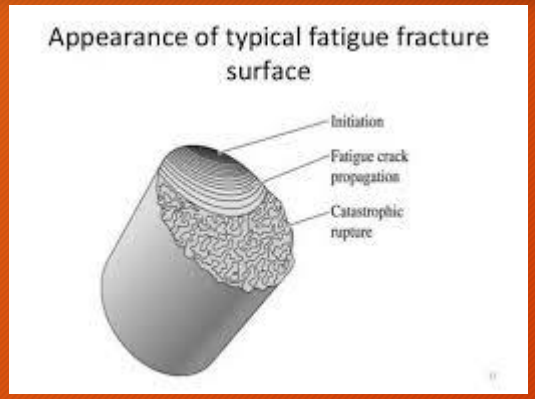
## Wachel

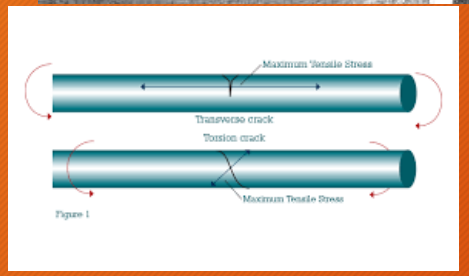
Uninsulated pipe < 304 mm/s peak
Pipe with concentrated mass load < 13 mm/s peak

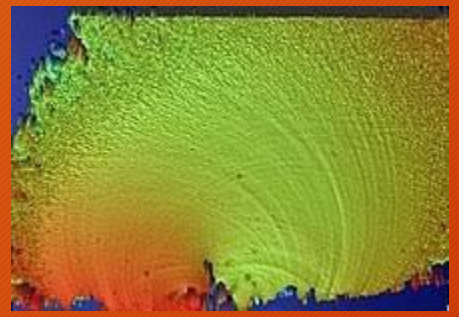
2021-11-04

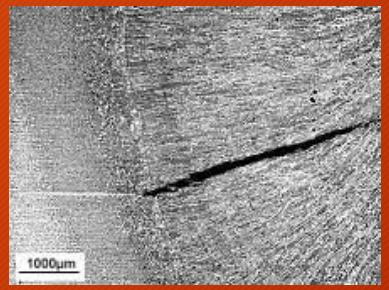
# What type of damage have you seen?






- High cycle fatigue
- Low cycle fatigue
- Thermal fatigue
- Guillotine break
- Aging

# Be prepared to what issues you are facing

Do not go to a measurement with “fingers in you ears”.

**Half the job is done at the fika table**

# There are always an advatage to use multiple transducer types

- Multiple transducers help you see more complex situations.
- If the system has transient behaviour there are a lot of parameters you want to know about it.
  - Try to get as many as possible in the same measuring system.
  - If you just have one type use more than one position.
  - Use known information damage investigation, calculations, experiences, “control room chat”

# To many thoghts how to measure

We always do like this!

- One type of transducer for all applications
- Measure continuous during known occasions
- Use periodic monitoring to measure the state of the system.

- This can work if there is a well known phenomena that is continuous

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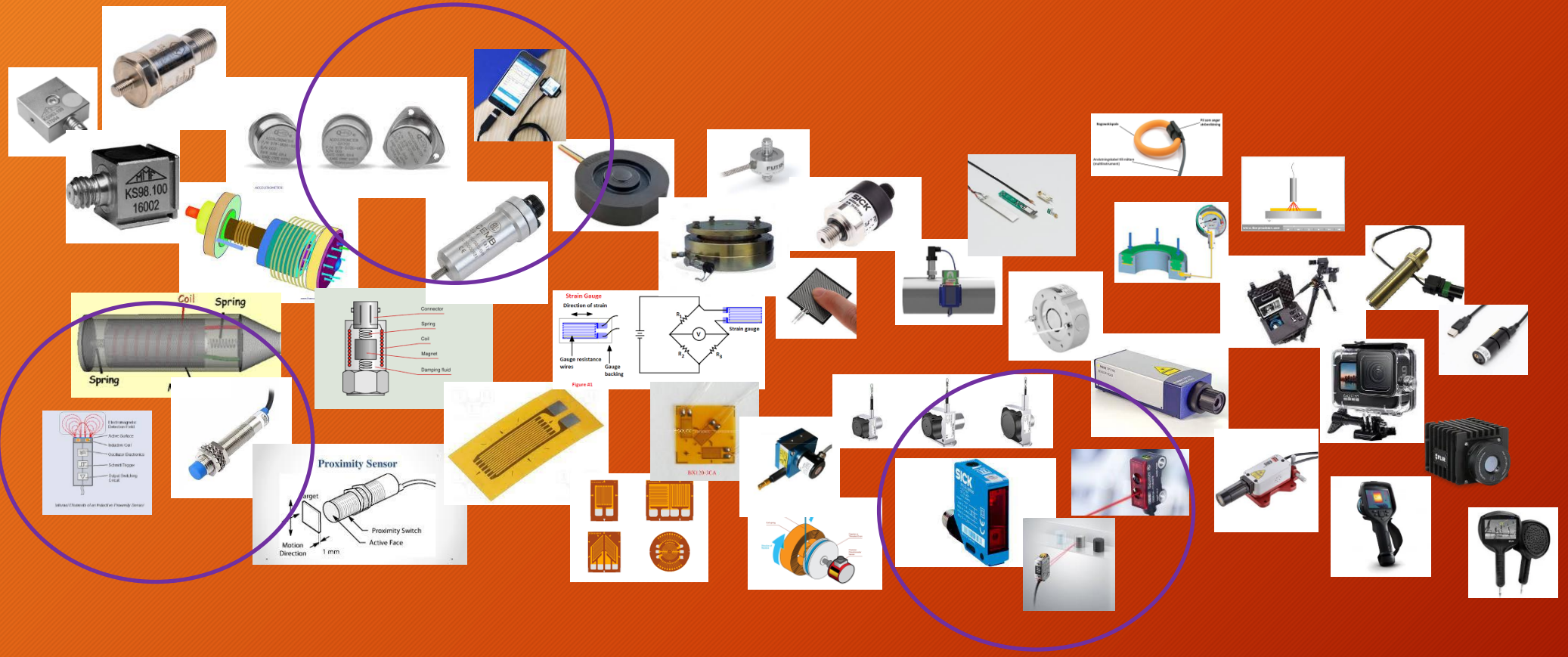
## How will we get as much information as possible?

- Using different types of transducers from the beginning
- Searching all types of occasions, all time 24/7.
- It locks a measuring system for a long time
- This is a hard time evaluation but you can find the out of the box occasions


And others

# There are a lot of transducer types

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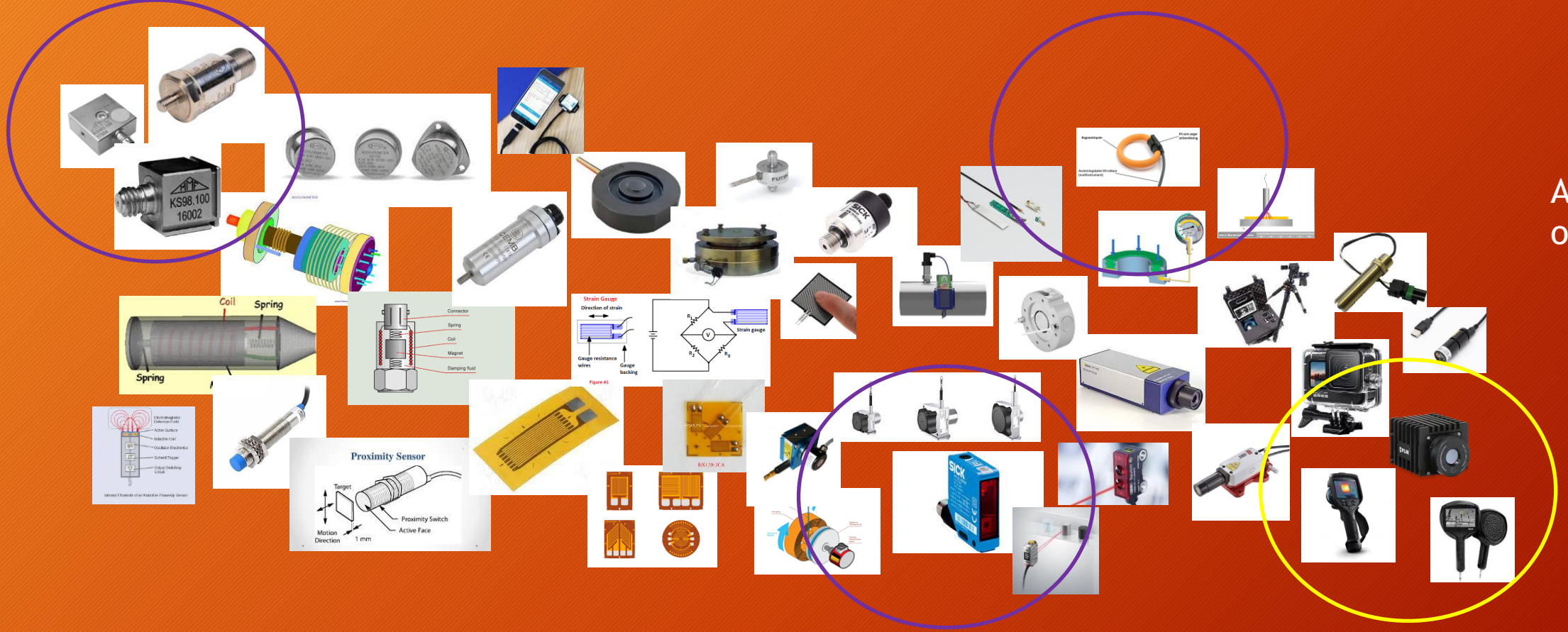


And others

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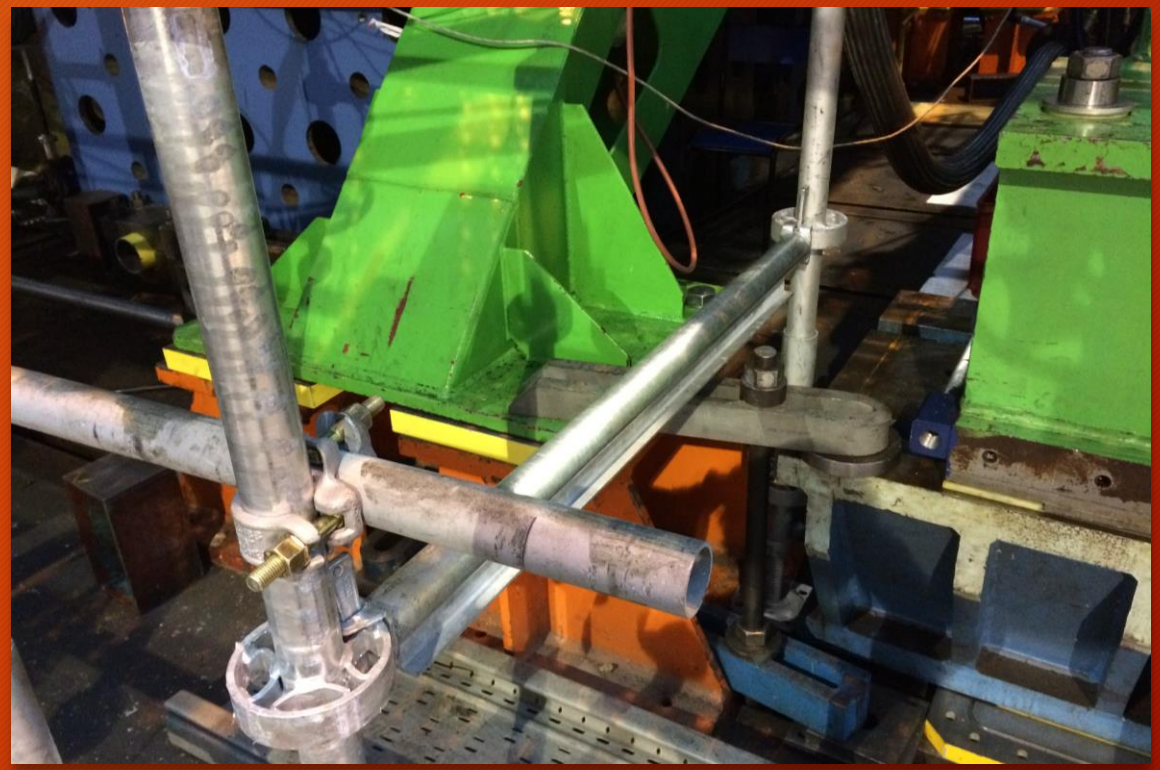
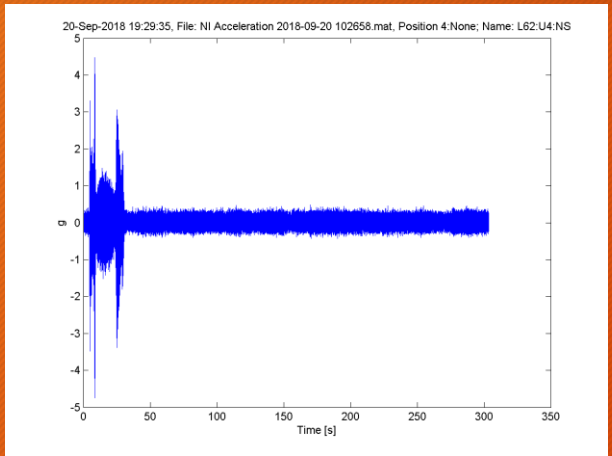
# How to choose?

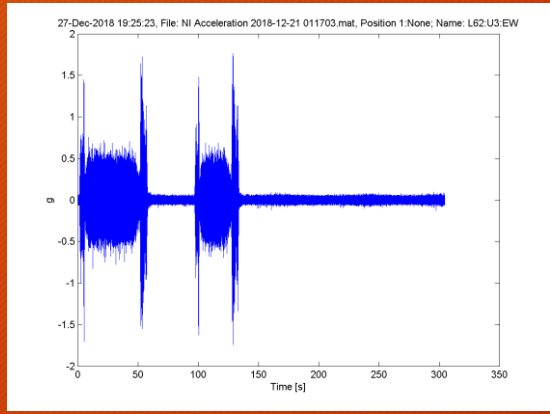
- **What are expected?**
  - Results
  - From the ”custumer”
- **What purpouse are there?**
  - Damages
  - High vibration
  - Monitoring requirements
- **If possible choose more than one type**
  - Combinations can give another answer
  - Limitations



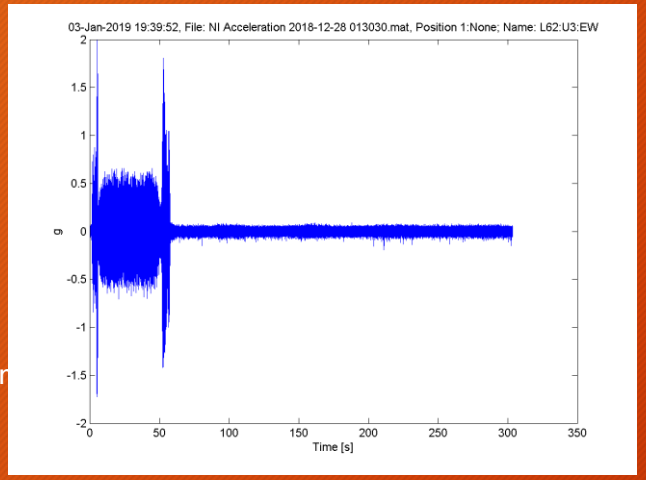
# What’s this?




There were short ones



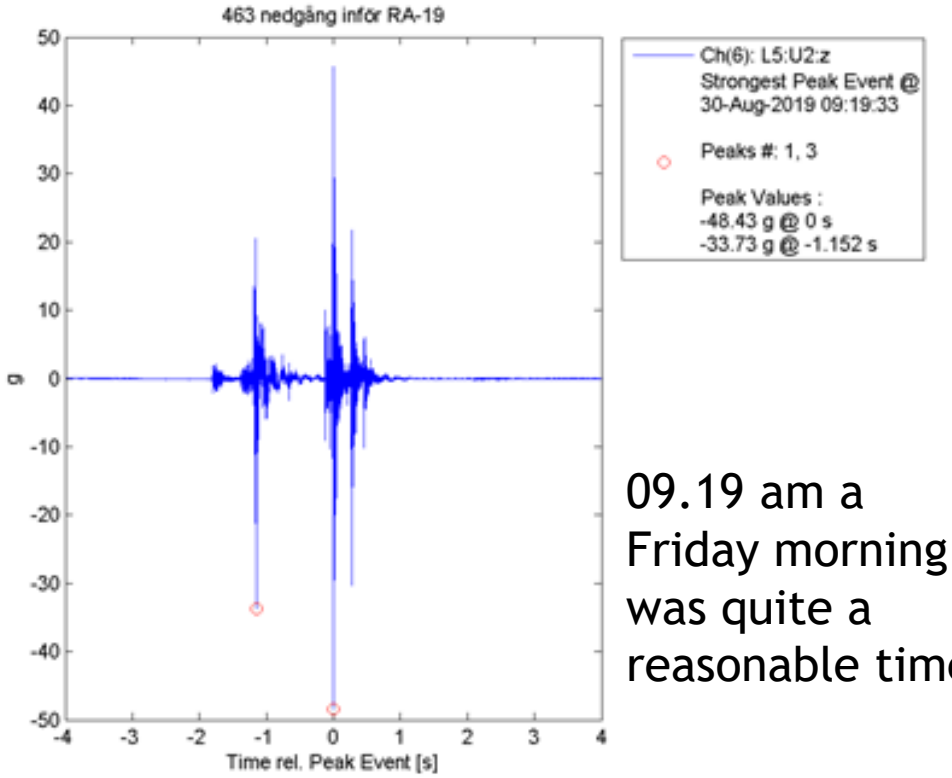

Double ones



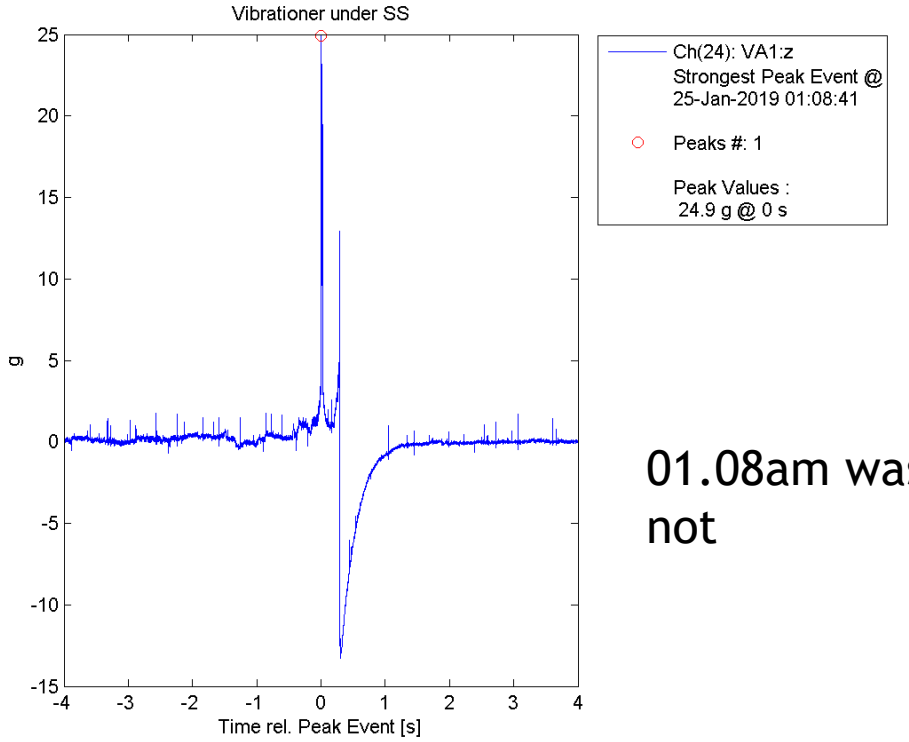

There were long ones even up to several minutes

*This happened about1am every Saturday morning*

# Short compromising occations

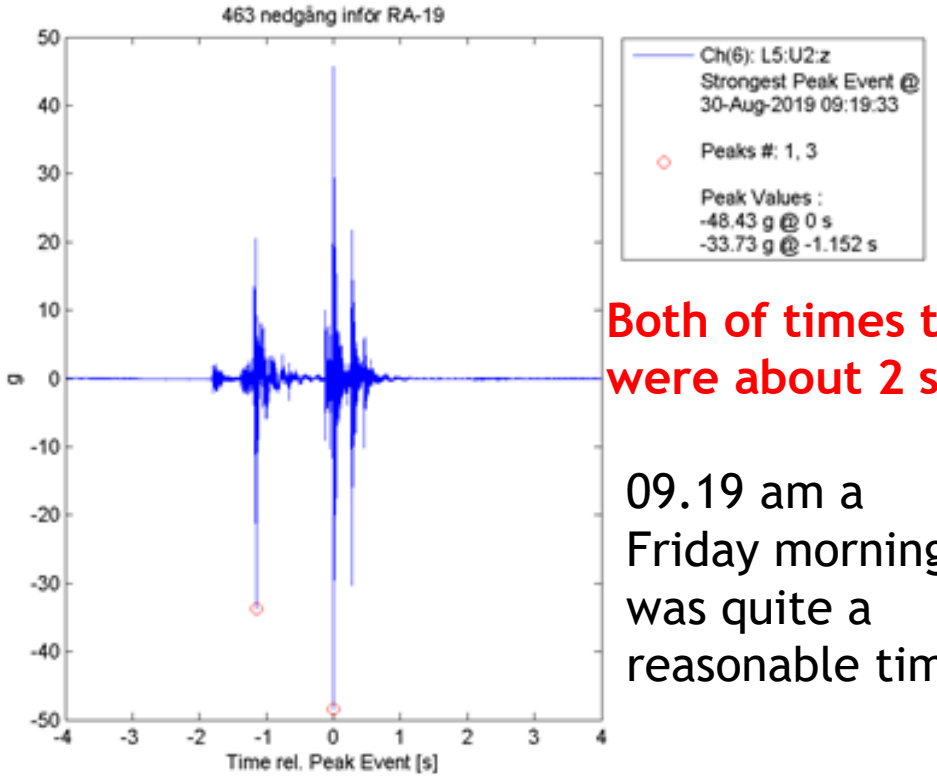



09.19 am a Friday morning was quite a reasonable time




01.08am was not

# Short compromising occations




**Both of times the length if the occation were about 2 seconds and unplanned.**

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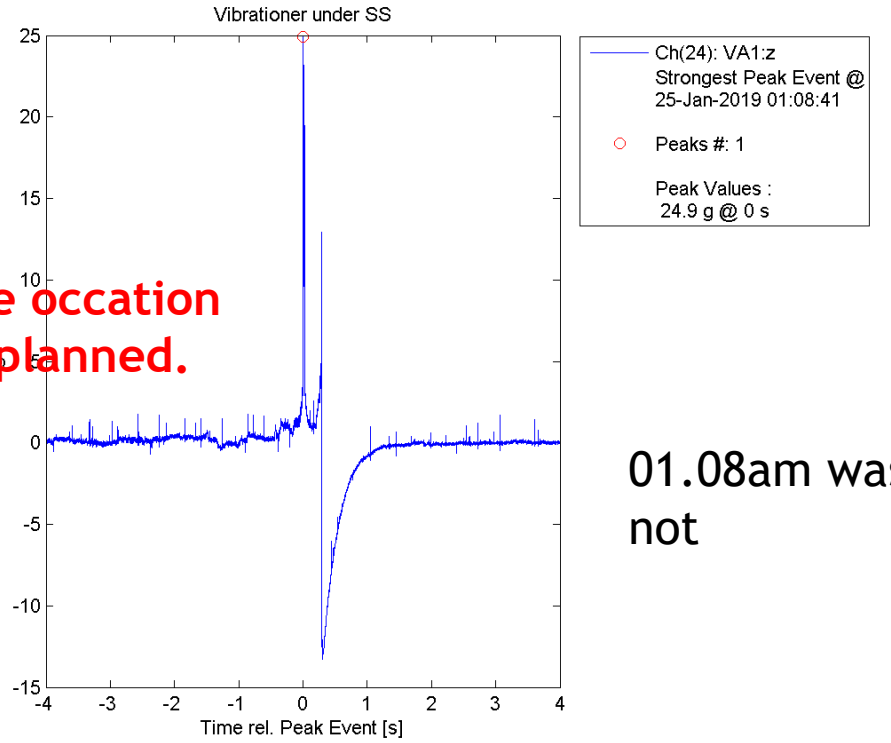
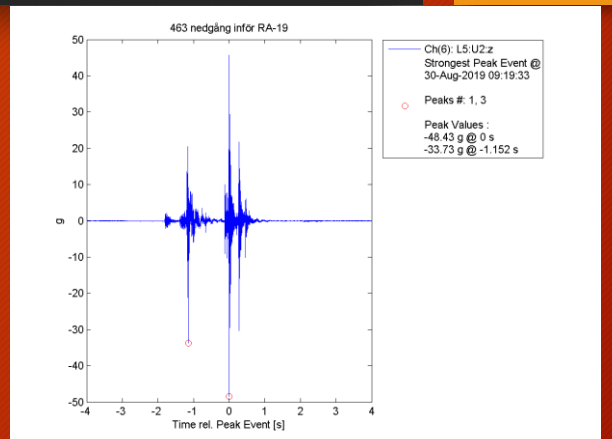
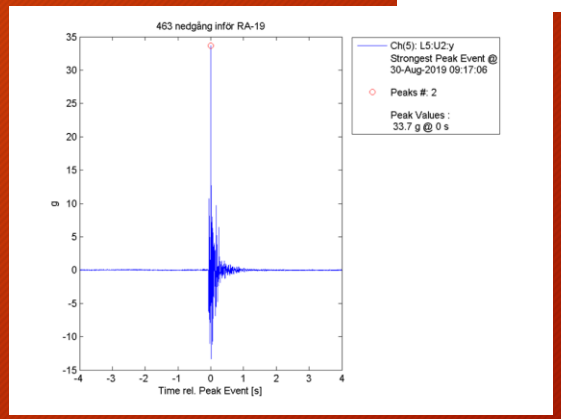


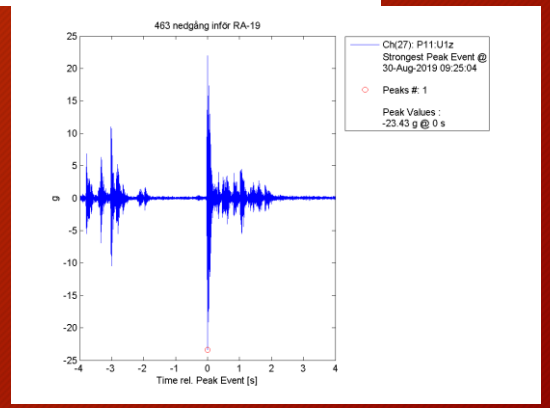

01.08am was not

# Turbine stop

- Turbine stop from feed water pumps
  - In this case it was low load and only one of three feed water pump was in operation
  - There were three separate occations that trigged high transients in the duration of eight minutes
    - 9.17 TS
    - 9.19
    - 9.25
  - The highest transient amplitudes are measured close to the pumps standing still.



# Recommendation

- Measure continuous if possible
  - Shorter period, approximately a week, better than nothing
  - During a known test. Start the measuring well before test start
- Choose equipment and technics before you arrive BUT
  - Have a plan B
  - Take a little extra with you
- Beware of safety restrictions
  - This can affect yor plan

# Thank you

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