SEEING PIPING VIBRATION AS A SYSTEM

A Practical Guide to Camera-Based Piping Vibration Investigations

A technical white paper for reliability engineers, vibration analysts, maintenance leaders, and piping specialists in industrial manufacturing, pulp and paper, metals and mining, and power generation.

Brea Parke | RDI Technologies | Knoxville, TN



A piping run in Motion Amplification® 5.2, set up as individual pipe objects, each with its own distance markers.

Introduction

A vibrating pipe is rarely just a vibrating pipe. The movement you measure at one point is usually the visible end of a chain that runs through supports, small-bore connections, nearby pumps and compressors, and the structure holding it all up. Find the right link in that chain and the fix is often simple. Chase the wrong one and you can tighten, brace, and re-measure for weeks.

That chain usually starts at equipment reliability teams already watch closely: pumps, compressors, fans, and blowers. When vibration readings on the machine or the pipe are inconclusive, or a repair request stalls for lack of evidence, the missing piece is often a view of how the whole system moves.

This paper is for teams who have been on the wrong end of that chase. It covers:

- Why piping vibration behaves as a system, and why point measurements alone can leave gaps
- How camera-based, full-field measurement adds spatial context to a vibration survey
- What Motion Amplification® 5.2 adds for piping: a purpose-built acquisition workflow and piping alarm visualization on Iris aiONE™
- A five-step investigation workflow, and what a defensible piping report should contain
- Where the technology fits in a reliability program, and where engineering judgment must take over

The Challenge: Piping Vibration Is a System-Level Behavior

Piping vibration matters because of where it can end: vibration-induced fatigue at welds, small-bore branches, and support attachments, which can lead to leaks and unplanned shutdowns. The difficulty is that the excitation and the damage are often in different places.

A pipe run responds to everything connected to it. Common sources include:

- **Mechanical excitation** from pumps, compressors, and other rotating or reciprocating machinery
- **Flow-induced excitation**, including turbulence and pressure pulsation
- **Transients** such as valve closures and start-up or shutdown events
- **Structural conditions** such as loose, missing, or undersized supports, and spans that sit close to a natural frequency

A point sensor answers one question well: how much is *this* location moving, and at what frequencies? But the questions a reliability team actually has to answer are spatial:

1. Which sections of the run are moving, and which are not?
2. Are adjacent sections moving together, or against each other across a support?
3. Is a small-bore branch or instrument connection responding more than the main line?
4. Where should the next measurement, inspection, or support change go?
5. How do we show a piping engineer or plant manager what we are seeing?

Answering these with point measurements alone means moving sensors from location to location, often by trial and error, and stitching the results together. Movement between measurement points can be missed entirely. And small-bore connections are frequently left out of surveys because instrumenting them all is impractical.

The objective of camera-based measurement is not to replace established vibration analysis or piping engineering practice. It is to fill in the spatial picture so that the rest of the investigation is better aimed.

How Full-Field Measurement Works

Motion Amplification® turns a high-speed, high-resolution camera into a non-contact displacement measurement system. Every pixel in the field of view acts as a sensor, so an entire pipe run, its supports, and the connected equipment are captured in one recording.

From that single recording, an analyst can:

- **See the movement.** Motion Amplification® video makes sub-visible movement visible, so the pattern of movement along the run can be seen rather than inferred.
- **Isolate a frequency.** Filtering the video to one frequency separates, for example, pump running-speed response from other movement in the same scene.
- **Map it.** A Motion Map colors the image by amount of movement; a Phase Map colors it by phase, showing whether neighboring sections move together or opposite one another.
- **Measure after the fact.** Time waveforms and spectra can be extracted from any point in the image after recording, without deciding sensor locations in advance.

	Point sensors (accelerometers, handheld probes)	Full-field camera measurement
Coverage	The locations you chose to instrument	Everything in the camera's field of view
Contact	Mounted or held on the surface	Non-contact; no surface preparation
Choosing locations	Before measuring	Before or after recording
Spatial relationships	Inferred by comparing separate readings	Seen directly in video, Motion Maps, and Phase Maps
Typical strengths	Continuous monitoring, high-frequency content, established severity criteria	Surveying large areas, small-bore connections, supports, and communicating findings

	Point sensors (accelerometers, handheld probes)	Full-field camera measurement
Typical role in a piping investigation	Quantify and trend known locations	Find where to look, then measure across the scene

The two approaches are complementary. Camera measurement shows *where* and *how* the system moves; point sensors and engineering analysis confirm *how much it matters*.

Purpose-Built Piping Tools: The Motion Amplification® 5.2 Example

Camera-based measurement is most useful on piping when capture and review are organized around piping rather than adapted from general machinery surveys. Motion Amplification® 5.2 is one example. On Iris aiONE™, it adds purpose-built piping acquisition and piping alarm visualization, both based on Energy Institute guidance, along with distance-aware measurement for Iris M™ and Iris aiONE™.

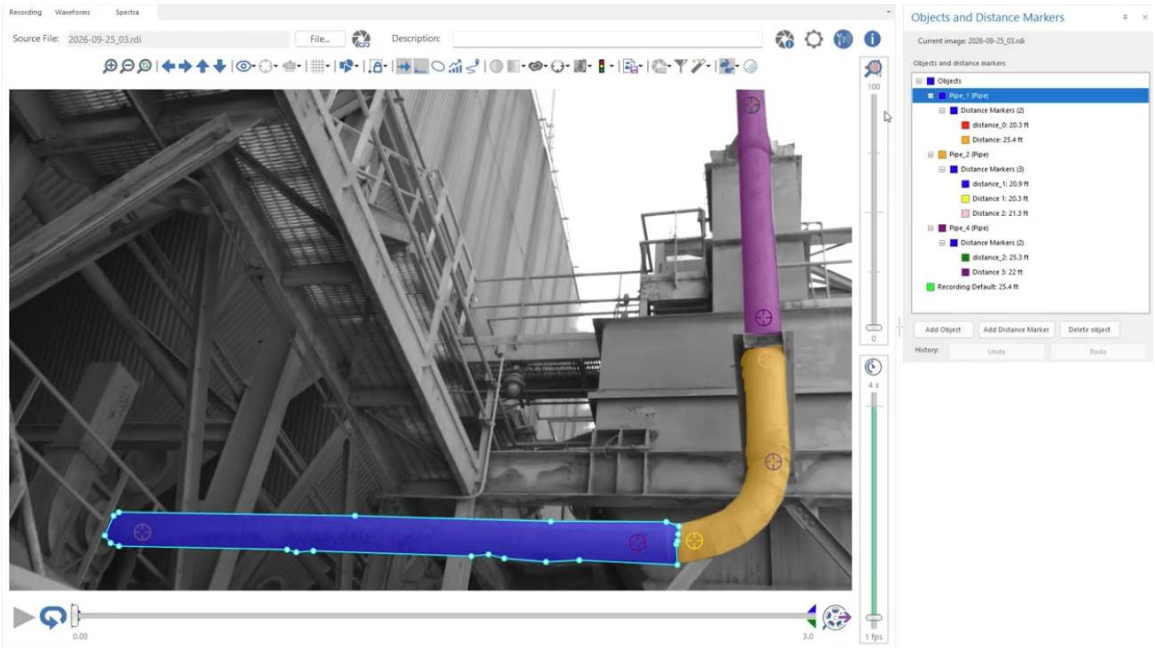
Purpose-Built Piping Acquisition

A dedicated piping acquisition mode, based on Energy Institute guidance, organizes capture around piping and carries the recording into the piping workflow. Investigations get a repeatable starting point, with fewer setup decisions and a shorter path into analysis.

Piping Alarm Visualization

Piping alarm visualization shows piping alarm states and lets analysts review measured movement against guidance-based evaluation thresholds, with the evaluation shown alongside the video evidence. Closer review can then focus on the locations and conditions that need attention, and maintenance and operations can agree where an inspection is needed.

An alarm indication is a starting point, not an answer. The alarm evaluation shows where to look; the Motion Amplification® video, frequency data, and Motion Maps from the same recording help explain why that section is moving. A flagged location begins a closer engineering review, confirmed with corroborating data and engineering judgment, not a replacement for them.



The 5.2 piping workflow on Iris aiONE™: a run set up as pipe objects, each with its own named distance markers. Display colors identify each pipe section; they do not indicate alarm severity.

Distance-Aware Measurement Across the Whole Run

Pipe runs rarely sit at one distance from the camera. Version 5.2 adds distance-aware measurement tools for Iris M™ and Iris aiONE™ that help teams interpret calibrated measurements across runs and structures that recede from the camera.

Field challenge	How 5.2 addresses it	Why it matters on piping
A pipe run recedes from the camera	Linear Depth Calculation calibrates measurements using the distance at each location between two distance references	The run is not treated as a single constant distance
The best camera position leaves the run off-center	Off-Center Measurement Correction accounts for the object's position in the image	Less need to reframe a run solely to center it
Calibration setups on irregular runs are hard to check	Named, editable distance markers, with multiple points tied to the object under review	Colleagues can see how a measurement was calibrated

Field challenge	How 5.2 addresses it	Why it matters on piping
Edited or shared recordings lose setup context	Distance markers stay with the recording through supported edits and Motion Explorer™ rename, import, and export	Less repeated setup when analysis is continued or handed off



Named distance markers along a piping run in 5.2, set between 20.3 ft and 25.4 ft from the camera.

Distance setup and suitable capture conditions still matter for measurement quality.

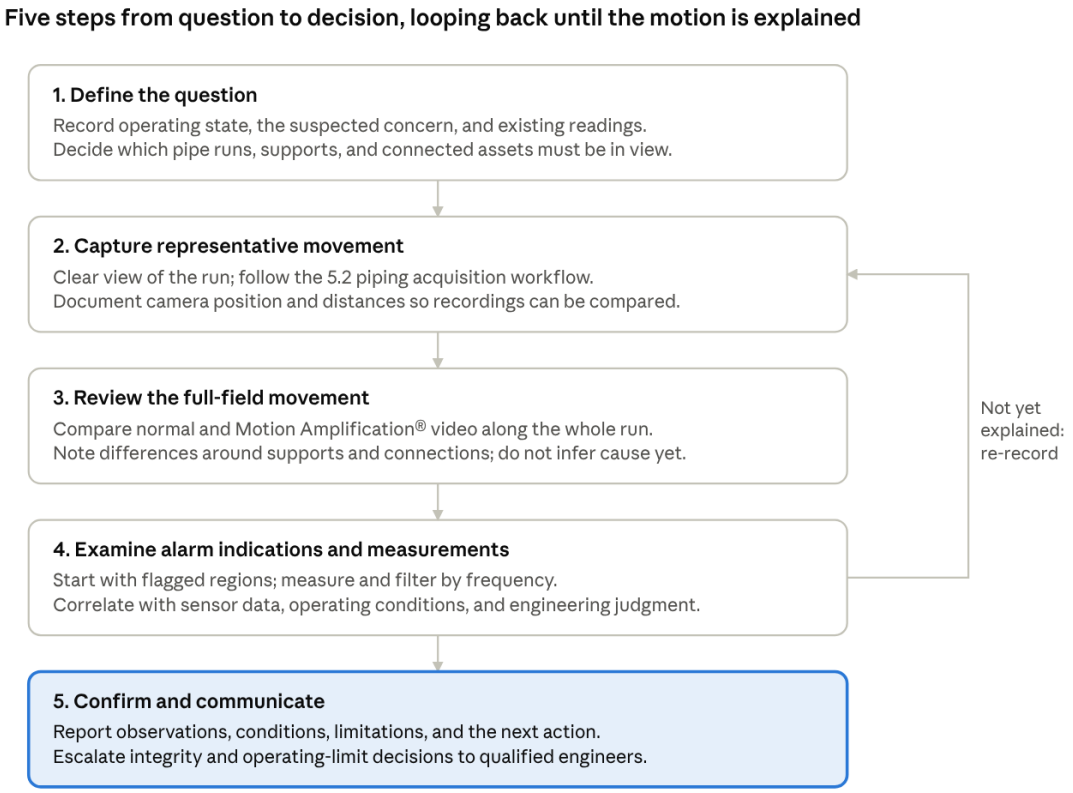
Clearer Evidence for the Report

- **Focusing Modal analysis on the event.** When a span is suspected of resonance, Modal Windowing Optimization (None, Low, or High, for impact projects) focuses the analysis on the useful span around an impact event, so lower-amplitude modes can be reviewed with less distraction from unused portions of the recording.
- **Keeping measurement context in shared evidence.** Regions of interest can remain visible in exported GIFs and reports, so reviewers can see where movement was measured.

Distance-aware measurement, Modal windowing, and reporting apply to both Iris M™ and Iris aiONE™. Piping acquisition and piping alarm visualization are specific to Iris aiONE™.

A Practical Piping Investigation Workflow

A good investigation moves from a clear question to a confirmed, communicated decision. When the evidence does not yet explain the movement, the right move is another recording under different conditions or from a different view, not a guess.



Piping investigation workflow · 5 steps, 1 loop

Steps 1 to 3 build the visual picture; step 4 is where 5.2's alarm visualization narrows the search; step 5 turns findings into an action someone can approve.

From the Field: Seeing a Pump Drive Its Piping

An RDI field survey of a pump and its connected piping shows why spatial context matters. Filtered to 8.82 Hz, the running speed of a pump, a Motion Map highlighted strong movement on the pump and along the connected piping, while the surrounding structure stayed quiet. The survey predates 5.2 and illustrates the visualization approach.

A single sensor on the pipe would have recorded a peak at 8.82 Hz. The Motion Map shows something more useful: where that energy travels, which sections respond most, and where the next

measurement or support review should focus. That is the question the 5.2 piping workflow is built to answer more consistently.

What a Defensible Piping Report Shows

A useful piping report separates observation from interpretation. The observation might be that one span moves visibly more than an adjacent supported section at a given operating condition. Attributing that movement to a mechanism, such as a loose support, a resonant span, or pump excitation, requires further evidence.

Report element	What to include
Asset and location	Line number, pipe run, supports, and connected equipment in view
Conditions	Date, operating state, flow or load, equipment running
Camera setup	Viewpoint, distance references, and acquisition settings
Visual evidence	Selected frames or video, with measured regions retained
Key observations	What moved, where, and at which frequencies, stated plainly
Alarm indications	Which regions were flagged in 5.2, and what review followed
Corroborating data	Point-sensor readings, spectra, process data, inspection results
Limitations	View obstructions, operating conditions not captured, measurement uncertainty
Next action	Follow-up measurement, inspection, support change, or engineering review

Where This Fits in a Reliability Program

Camera-based piping investigations complement point-sensor surveys and continuous condition monitoring. They are most valuable when a team needs to:

- Survey a large or congested piping area quickly to decide where to focus
- Check small-bore connections and instrument branches that are rarely instrumented
- See how pipe, supports, and connected machinery move relative to one another
- Choose follow-up measurement locations based on evidence instead of guesswork
- Baseline a system before a change and confirm the effect after a repair
- Explain a complex movement pattern to piping engineers, operations, and management

The technology does not replace vibration expertise, engineering assessment, operating limits, or applicable piping guidance. Decisions on structural integrity, fitness for service, or continued operation belong with qualified engineering personnel.

What It Means for Each Role

Role	What they need	What a piping investigation gives them
Reliability or maintenance lead	An explanation for repeat problems that existing data leaves unresolved	A view of how the pipe, supports, and connected machinery move, and where to measure next
Plant or operations leader	Clear evidence to approve a repair and justify its cost	Video and measured regions that tie a finding to a specific repair, weighed against the site's own repair and downtime costs
Corporate reliability sponsor	A workflow that can be repeated across sites	A consistent piping acquisition mode, documented results, and a model other facilities can follow

Conclusion

Piping vibration is a system problem, and solving it starts with seeing the system. Point sensors tell you how much one location moves; full-field measurement shows how the run, its supports, and the connected machinery move together, and where the next question should be asked.

Motion Amplification® 5.2 builds on that full-field view with a purpose-built piping acquisition workflow and piping alarm visualization on Iris aiONE™. The result is a more consistent survey and a faster route to the regions that deserve engineering attention.

For teams facing unresolved piping vibration, the next step is straightforward: record the system under representative conditions, review the visual and quantitative evidence together, and bring the right engineering expertise into decisions about risk and remediation.

See It on Your Own Piping

Have a pipe run, pump, or compressor system that your vibration data hasn't explained? Tell RDI Technologies about it. Our team will review the problem with you and show what Motion Amplification® 5.2 can reveal on your own equipment.

REQUEST A PROBLEM REVIEW > rditechnologies.com | marketing@rditechnologies.com

About RDI Technologies

RDI Technologies develops Motion Amplification® camera and software solutions used by reliability, maintenance, and test and measurement teams to see and quantify vibration across entire machines, structures, and piping systems. Its technology supports troubleshooting and root-cause investigation in industrial manufacturing, pulp and paper, metals and mining, and power generation.

Seeing is Believing.

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