



# A Clearer Future:

Innovations in Video Borescope Technology  
for Remote Visual Inspections





## Overview

Portable remote visual inspection technology with embedded expertise and remote collaboration has enabled non-destructive testing (NDT) professionals and asset owners to drastically reduce the risk of serious failures, without experiencing unnecessary equipment damage.

By making remote visual NDT technology more efficient, reliable, and accessible, the aerospace, oil and gas, and power generation industries have already greatly improved uptime for systems and equipment—ranging from tray towers and columns, to high-value rotating equipment, like gas turbine generators and aircraft engines.

But while video borescopes are of critical importance for visual inspections in these applications, the full potential of what current RVI imagery tools can yield remains somewhat limited by resolution. On-the-spot decision-making is subsequently hampered by the standard-definition images and limited working range that standard borescopes offer.

As compliance regulations tighten across industries, increasing pressures for more precise inspections continue to mount. At the same time, organizations must also grapple with the challenges of reducing operating costs, while simultaneously making process and testing improvements. The need for faster, more accurate inspections—and the tools required to achieve them—has never been greater.

The need for faster, more accurate inspections—and the tools required to achieve them—has never been greater.

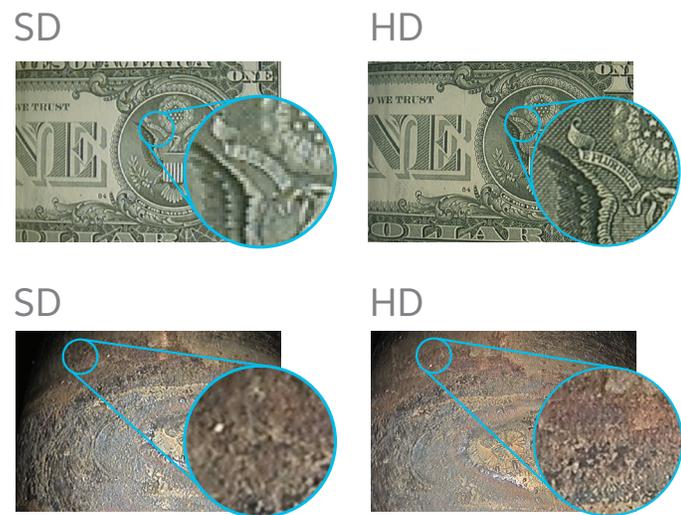
# The Current State of Remote Visual Imagery

Among the most significant factors limiting the quality and richness of current borescope imagery is the resolution of the camera. Due to the size requirements of the borescope, it is typically 6 mm or less in diameter. In practical terms, users often note that even the most advanced imaging technology currently available is inferior to images they are able to capture on consumer smartphones.

In fact, the standard definition quality of images that current borescope technologies are capable of capturing has rendered the digital zoom feature somewhat lacking in many industrial application settings. Digital zoom for standard definition images seldom affords any practical advantage, as images quickly become too pixelated to detect and assess indications with adequate precision.

## Emerging Innovations in Borescope Technology

New advancements in high-definition (HD) technology provide more pixels per image. This gives inspectors unprecedented image quality and enables digital zoom as a powerful tool.



Additionally, complementary innovations in videoscope technologies enable measurement of larger indications from larger distances with accuracy and precision.

Such technological progress will help organizational leaders and inspectors alike within these sectors tackle many of the most daunting challenges they face.

## Quantitative Improvements: The Real Impact of Greater Efficiency, Precision, and Accuracy

### Time

The most common borescope inspection applications in the energy sector include compressor inspections in power plants, inspecting turbines for shim migration and other potential problems, and heat exchanger and tower inspections. However, there are countless other remote visual inspection tasks. Each varies widely by application in time to complete. An inspection for shim migration, for example, typically takes between 15 minutes and half an hour. Though regardless of application, multiple optical tip adapter changes or position adjustments using legacy remote visual inspection devices mean slower inspections.

With enhanced digital zoom capabilities enabled by HD imaging, inspectors can capture sharper images that identify smaller indications from farther distances. This makes inspections much faster and easier to conduct, which results in images that are much more useful. Users are then able to view these high-resolution images directly on their devices mid-inspection, and make more immediate decisions.

Such clarity easily eliminates the need to repeatedly halt the inspection, change the optical tip adapter and relocate the precise inspection area again in order to assess the severity of an indication—a process that, for this use case, can easily take over fifteen minutes, and possibly hours to once again locate the indication with the measurement optical tip installed. Over the course of a day, a week, and eventually each year, reducing even a small fraction of the time required for every inspection can result in significant efficiency gains.

reducing even a small fraction of the time required for every inspection can result in significant efficiency gains.

With high-definition and 3D-enabled borescope technologies, inspectors can achieve more efficient, precise inspections, and increase Probability of Detection (POD) for key indicators such as corrosion, blockages, missing turbine blade coatings, and cracking.

#### Financial Impact

Limitations in standard definition images create doubt around potential issues or indications that are nearly (or completely) invisible. For example, if an inspector is trying to examine a potential crack in a turbine stage that is only visible between blades, but cannot get a probe into the correct position, s/he may waste valuable time only to then make an incorrect determination with potentially significant consequences.

Consider the effects of this decision on a large gas turbine inspection. Once the indication is deemed a defect, a full inspection must be conducted to identify and implement corrective actions. But first, the turbine must be disassembled. This could translate to nearly a week of

downtime, and millions of dollars in lost revenue. With clear, precise remote visual imagery available on the device and on demand, and the ability to measure from further distances, inspectors would be able to make better, more informed decisions from the start.

This could translate to nearly a week of downtime, and millions of dollars in lost revenue.

## Use Case Examples

### Heavy-Duty Gas Turbine Generator Inspections



Crisp HD image quality, coupled with 3D measurement capability, can help dramatically improve the probability of detection and assessment of the severity of an indication of pitting, cracking, wear, and tip rub across lengthy gas turbine inspection areas. Additionally, inspectors can check for stator rocking and tip-to-shroud clearances more easily, from farther distances, without needing to navigate the borescope probe between stages in the compressor. This can translate into reduced inspection times of up to 25 percent or more—meaning a full inspection of 14 fuel nozzles, combustion chambers, the turbine, the inlet house, and the compressor section could be completed in just six hours instead of the typical eight.

## Boiler Assessments

When conducting tube inspections for a boiler furnace, which can be comprised of hundreds or even thousands of tubes, inspection times would be greatly reduced by introducing superior HD image quality and illumination into these confined spaces. Also, enhanced 3D measurement capabilities may reduce the need for other NDT modalities to measure indications of corrosion and erosion pits in a tube, which translates into still more cost savings. A typical boiler tube integrity assessment, which might include searching for tube stops in two separate 70-foot headers, would normally take more than an hour per header. The technological improvements listed above could save up to three hours of inspection time per assessment and eliminate costly downtime.

## Columns and Towers

Remote visual inspections of columns' and tray towers' filtration or bedding media can be quite challenging. Vapors can greatly reduce visibility, rendering standard definition imagery much less useful than it would be otherwise. While HD cannot cut through vapor, it certainly could provide a sharper image once that vapor has settled.

Also, since HD enables a clearer picture from farther away, fewer access points would be needed to insert the borescope, which means a significant amount of time could be saved.

While many variables determine what kind of time and cost savings are realized in column and tower assessments (such as height, number, and location of entry points, etc.), if inspectors are able to eliminate one half of a shift, a significant reduction in both is achievable. Ultimately, any portion of an entire production day restored can return a tremendous amount of value.

## Qualitative Improvements

### Long Distance Measurement Capability

New long-range 3D measurement optical tip adapter innovations enable full 3D surface scanning at more than twice the standoff distance supported by current offerings. The larger working range, combined with more than four times the useful scan area, enables fast, accurate measurements of larger features such as long cracks, weld geometries, coating loss, and blade tip clearances.

Performance on challenging surfaces, such as shiny turbine compressor blades, is also substantially improved. Simply put, these latest innovations can make indication assessment performance at longer distances significantly better, enabling 3D measurement of a variety of larger areas.

### Making Digital Zoom More Useful

With HD imagery, digital zoom becomes a much more useful tool. For example:

1. When viewing an image from a 440K pixel SD sensor on a 6.5 inch XGA (786K pixel) display, the image may become visibly pixelated at 2.0X digital zoom.
2. With a 1.2M pixel HD sensor, the same level of pixelation would occur at 3.3X digital zoom due to its higher pixel count.
3. Thus, a small indication will appear almost 70 percent larger with the HD sensor before it appears pixelated, making it easier to evaluate without moving the tip of the borescope closer.

**An HD sensor adds 1.7 times as many pixels horizontally and vertically.**



# The Future Has Arrived.

 Cutting-edge HD image quality

 Intuitive innovation

 Flexibility for faster inspections

 Performance meets portability

 Advanced detection and analysis

 Real-time connection

For the first time, GE has brought all of these technological advancements to market by improving on its most revolutionary videoscope solution: the Mentor Visual iQ VideoProbe\* with HD capability, unlocking the full power of digital zoom.

As the industry's first portable borescope with Real3D Measurement\* Fully Surfaced Point Cloud Analysis using Advanced 3D Phase or 3D Stereo Measurement technologies, Mentor Visual iQ pushes the boundaries of the inspection landscape. And now, with High Definition TrueSight Imaging\* and a new long-range 3D Phase Measurement tip, inspectors can detect and quantify smaller indications from greater distances and readily share that findings with others via enhanced digital connectivity.

GE's Mentor Visual iQ delivers unprecedented measurement precision and accuracy for faster, more informed decision-making by providing the portability, advanced assessment features, enhanced connectivity, and custom tools and accessories needed to improve inspection efficiencies and measurement quality in industry today.

**To experience how GE is continuing to revolutionize the digital inspection landscape, contact your sales representative for a demo, or learn more at [www.gemeasurement.com/](http://www.gemeasurement.com/)**



© 2018 General Electric Company. All Rights Reserved. Specifications are subject to change without notice. GE is a registered trademark of General Electric Company. Other company or product names mentioned in this document may be trademarks or registered trademarks of their respective companies, which are not affiliated with GE.

\*Trademark of General Electric Company.