Elevated Body Temperature Screening at the Workplace
Bala Consulting Engineers COVID-19 Task Force
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INTRODUCTION

The use of camera systems to detect staff and visitor body temperature has become extremely topical because of the contagion rate of the COVID-19 virus, and recent clarifications by the US Equal Employment Opportunity Committee regarding the acceptability for employers to restrict access to a work site based on temperature screening.

Bala has been asked by a number of our clients to provide our insight on the use of IR thermal cameras, and more specifically thermographic screening, to detect fever in staff and visitors as well as our recommendation on which available technologies to consider.

Bala's current understanding on the use of thermographic screening, the technology, costs, procurement, and deployment considerations are outlined in this report. With the high demand for this technology and user requests for third party integrations and options, we expect rapid changes in the marketplace and will make updates to this report when necessary.

WHAT IS THERMOGRAPHIC SCREENING

More common outside of the US, identifying and isolating infected individuals using non-contact measurement techniques is now recommended by the CDC as a "minimal to moderate" mitigation activity to prevent COVID-19. Thermographic screening or Elevated Body Temperature Screening (EBT) is a non-contact measurement technique that has been in use since the SARS outbreak in 2002 and more recently for the H1N1 and Ebola outbreaks as a means of controlling the spread of infection. Thermographic Screening attempts to measure the surface temperature of an individual at the forehead or tear duct area via a non-contact infrared camera system to identify the potential for a raised body temperature which might indicate infection.

Due to the high volume of workers or guests entering some facilities, traditional manual non-contact temporal thermometers (gun systems) may not allow for the processing speeds necessary to keep a business entrance or lobby clear. Thermographic screening systems provide the opportunity to create a semi-automated queuing process for high volume temperature screening.

THE EXPLOSION IN PRODUCTS AND OFFERINGS

Once COVID-19 triggered the Department of Health and Human Services to declare a public health emergency, the FDA announced: "the FDA does not intend to object to limited modifications to the

indications, claims, functionality, or hardware or software of FDA cleared non-invasive remote monitoring devices that are used to support patient monitoring during the declared public health emergency."

This announcement has set off an explosion of companies modifying existing thermographic systems from industrial monitoring, fire detection and other uses to be used for body temperature sensing. In some cases, this has required companies to rapidly adjust camera sensitivity by narrowing the detection range and improving accuracy. We have also seen international manufacturers, primarily based in China, partnering with U.S. based distributors to sell existing thermographic systems.

FLIR Thermal Camera Core

We anticipate that many facilities will need to consider using newer to market products and roll out their screening capabilities in phases due to anticipated limitations in product availability and longer than average lead times. Additionally, until these products are proven through end user use, we caution all clients to have documented backup plans to address equipment failures and servicing delays in place. When evaluating system options, request information on the history of use in screening applications, use of OEM parts and the parts supplier background with screening products. This will help provide a level of comfort on the relative risk and help determine if an enhanced service contract from your local reseller is warranted.

THERMOGRAPHIC SCREENING LIMITATIONS

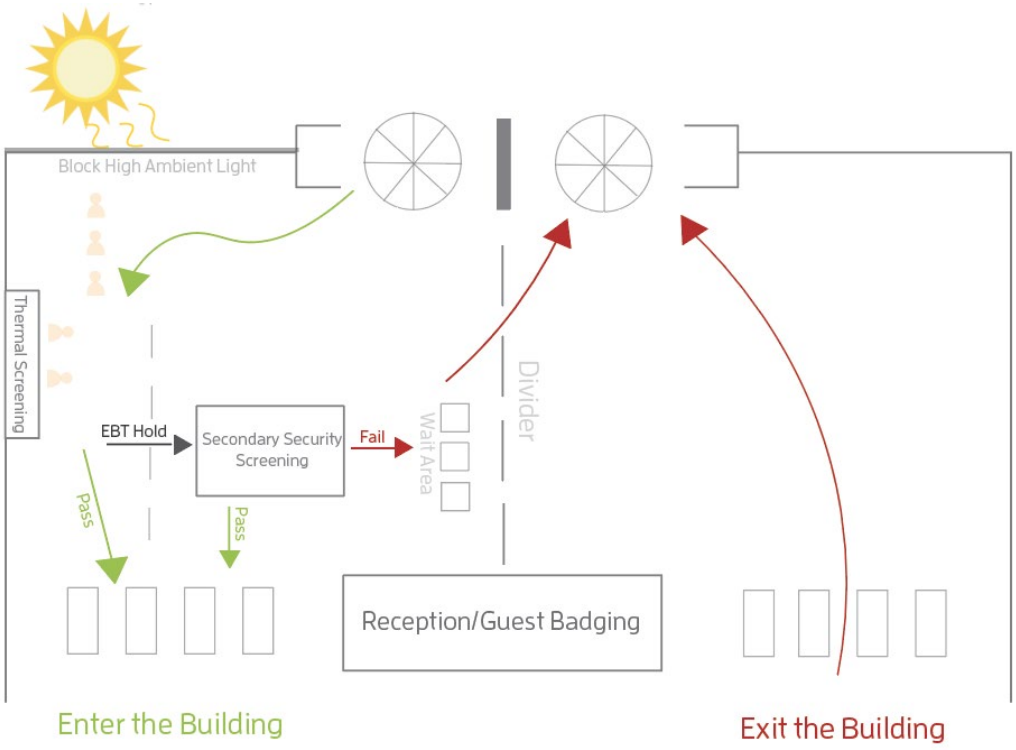
While thermographic screening improves processing speeds and reduces staffing needs in a facility, there are some limitations to the screening process and to the use of body temperature as a means of controlling infection. These limitations include:

- Temperatures may fluctuate due to the use of medications, recent physical exertion, gender, race or other factors sufficiently enough to cause misidentification.
- IR camera measurement systems are influenced by high ambient light or heat conditions around the test subject. Currently, higher quality systems have accuracy ranges typically in the ±0.5°C (0.9°F) range.
- Temperature screening cannot confirm the presence of COVID-19. People who are asymptomatic (from 2-14 days) may be just as contagious as those who have a fever or other symptoms.
- The FDA does not currently certify or approve many thermographic screening systems and manufactures have been careful to note these are not considered "Medical Devices." As such, final determination of elevated body temperature should be verified using an FDA approved device.

Because of these limitations, it is best to consider employing multiple screening methodologies with increasing human intervention.

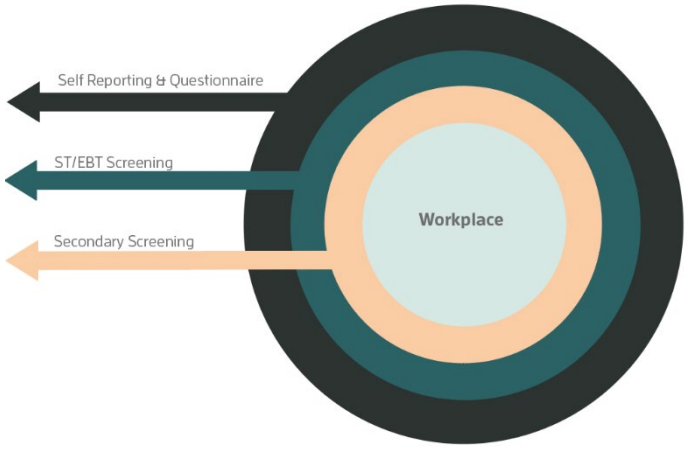
PREPARE YOUR SITE TO IMPROVE YOUR THERMOGRAPHIC SCREENING RESULTS

- Setup testing stations indoors.
- Keep cameras and sensors aimed away from high ambient light areas or where heat builds up.
- Add a color neutral, non-reflective, backdrop behind the sensing area.
- Users should remove headwear and eyeglasses if possible (but keep masks on so long as they do not block the eyes or forehead).
- Queue to the side of your sensing area to avoid systems detecting multiple people. Set-up the queue to allow for some wait time so users can acclimate to typical room temperature.
- Place distance marker on floor to maintain consistent measurement distance.
- In high volume lobbies, plan for multiple stations and allot 10-20 seconds per person.
- Create a secondary screening position for users with an Elevated Body Temperature (EBT).



THREE PART SCREENING

Similar to traditional physical or network security measures, a layered approach that creates rings of security with increasing levels of inspection can be deployed:



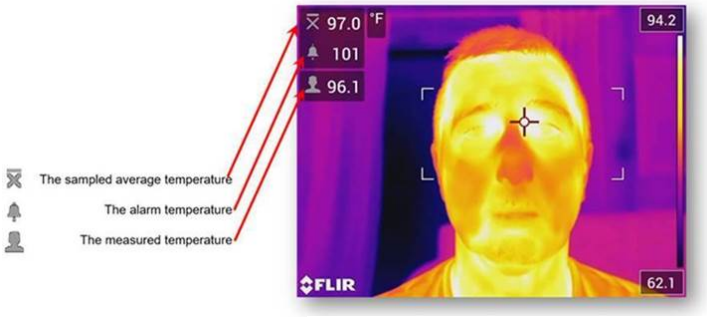
1. The outside ring – Self Testing
    a. Staff or visitors self-testing at home for fever and responding to a health questionnaire on temperature and respiratory symptoms to help prevent potentially infected staff from entering a facility.
    b. This method is most effective when paired with the CDC recommendations on implementing flexible sick leave and supportive policies and practices to encourage truth in reporting.
2. The middle ring – Thermographic Screening
    a. IR camera temperature screening helps provide elevated body temperature detection while meeting social distancing recommendations.
    b. Users testing within temperature range are granted access while those that have elevated temperatures move to the inside ring.
3. The inside ring – manual non-contact temperature measurement
    a. Trained staff, using non-contact temporal temperature measurement systems, assess individual users for COVID-19 symptoms and make individual determinations on access to the facility or request the user leave the premises and seek additional testing or monitoring.

Note - We have seen multiple references for specific waiting areas to give users who have elevated body temperature a place to sit while waiting for retesting or instructions, sometimes called “quarantine lounge.” As this is not yet common practice in the U.S., we would recommend consulting a health specialist to determine how to design and maintain a safe waiting area to prevent accidental transmission.

TEMPERATURE SAMPLING

Thermographic screening systems combine an infrared camera core with software analytics to identify a person and present an opinion on their body temperature. These systems typically look to detect a person’s temperature at the forehead or tear ducts. There are two different techniques to analyze measurements. Many systems work by setting a threshold temperature and then wait for the maximum read user temperature to break the threshold, sometimes averaging the maximum temperature read over a number of video frames to address possible sources of error.

A second method is to use a sampled average temperature across multiple users. The manufacturer FLIR, attempting to correct for temperature deviations from outside weather or other environmental factors, uses a baseline of 10 initial users each time the system is turned on to identify users with temperatures elevated across the group baseline. This system can be recalibrated multiple times a day as outside weather or factors change.



FLIR Sampled Average Temperature

INDIVIDUAL VS GROUP MEASURING

Previously, individual measurement was standard for screening systems. Recently, options for a single camera to read larger groups simultaneously, as many as 30 or more, have become available with some considerations:

COHUHD Costar 3210HD Sample Group Measurement

- These systems are not yet widely used in the US and in some cases have been repackaged and resold through a large variety of distribution chains. A pool of trained and experienced integrators or end users are not yet available to discuss their experience with these systems.
- Camera sensor sizes have not changed significantly from the individual measurement systems making the resolution per user detected lower when analyzing larger groups.
- While these systems can help reduce the number of staff needed to screen large groups and increase user testing rates, we anticipate a higher number of staff will be required to effectively isolate individuals in a large moving group.
- Prior to use, we recommend operators request a product demo and start by restricting user flow to half the stated max simultaneous capacity and ramp up to full capacity as operators get more comfortable with the system and its performance.

Another characteristic of the group sensing platforms that we reviewed is the use of AI to improve detection rates and provide facial recognition capability. This becomes necessary when attempting to track a single user in a large moving group; however, it may require businesses to address HIPPA or State employee data privacy regulations along with performing regular data security audits.

Facial Detection vs Recognition – All platforms on the market use some form of anonymous facial detection to map the regions and boundaries of the test subject in the field of view. Systems that utilize facial recognition have the ability to identify a face and match it with a known database entry.

CALIBRATION

All manufacturers surveyed indicated that their camera systems come pre-calibrated with a variety of options for calibration. Most manufacturers recommended returning the camera to the factory for yearly calibration. In some cases, installers who have the proper training and calibration equipment can perform field calibration. Some lower cost systems or the group system provide a smaller sensor area per person and utilize a "black body" reference heat source that is located within the camera's field of view to provide a constant known temperature to calibrate the rest of the image.

SYSTEMS COSTS

Costs for thermographic screening systems can vary significantly based on the technology deployed and overall maturity of the product line and feature set. Small format systems utilizing a sensor that snaps onto a mobile device or directly to a user PC can run as low as $2,000; however it has been difficult to get detailed information from manufacturers on accuracy when compared to the larger sensor units more prominently discussed in this write-up, so we cannot recommend them at this time.

Some costs for typical configurations are shown below with ranges provided based on thermal sensor size (which impacts capture distance) and accessories. Costs shown are for hardware only; installation, service, support and ongoing maintenance will vary heavily based on the contract type.

- Compact all-in-one options (sensor, display, stand) - $3,000-$4,000
- Rugged handheld units with tripod mounts - $7,000-$10,000
- Individual capture units - $10,000-$16,000
- Group capture units - $18,000-$25,000 (with costs escalating to network multiple cameras and deploy greater analytical capabilities)

SYSTEM PROCUREMENT

In response to current demand, many manufacturers are entering the market and currently advertising thermographic cameras for use with temperature screening. As such, we advise clients pay close attention to not only the products capabilities, but also how the products are distributed. Specific distribution items to consider include:

- Identify manufacturers with a local presence capable of providing system demonstrations and confirm local integrators certified in the installation and maintenance of the product. Confirm if manufacturers are able to provide onsite support if a local installer base is not present.
- Purchase through a technology integrator who provides a service contract separate from the manufacturer's warrantee.
- Request a yearly calibration plan that includes temporary replacements while cameras are being factory recertified.
- Request existing client references who can discuss system features and reliability.

EQUIPMENT LEAD TIMES

Screening systems manufacturers are currently providing lead times of as soon as 2-4 weeks and as long as 8-12 weeks. We anticipate the early lead times of 2-4 weeks will quickly extend as orders are placed. As a result, clients should expect to use more traditional screening procedures through May and June of 2020 and expect new thermographic systems to be installed around July and August 2020.

FUTURE AND UNIQUE APPLICATIONS

Most manufacturers we consulted noted that work is ongoing to develop additional applications for the platforms including AI based access control integrations, contract tracing software partnerships, unique mounting systems and I/O upgrades, some of which could be applied via firmware to existing systems. When reviewing hardware options discuss the product roadmap, including any integrations with your current platforms, to understand opportunities to leverage the platforms post-pandemic.

Some applications they discussed included:

- Integration of cameras into metal detectors, mantraps and other detection/isolation systems.
- Dual monitor systems which provide full temperature readings to the operators and separate instructions to users such as “cleared for entry” or “move to secondary screening.” This would help address privacy concerns and users tracking their own reading history.
- Integrated digital signage for use at a security desk or other less formal testing location where the displays could provide dual functionality.
- Integration with security platforms and visitor management systems to create automatic user access updates such as requiring passing a temperature screening prior to activating a daily security badge.
- Lobby entry systems which allow residents to confirm a visitor’s temperature before unlocking the entry door.
- Maintaining people counts, group pass/fail statistics and other trending information.
- Antibacterial interfaces on touch screens allow all-in-one systems to be used for guest badging.
- Extension into full building AI platforms.

SUMMARY

Thermographic screening, deployed properly with technology considerations, process and policy requirements, can be a valuable and useful layer of a multi-layer screening program to help reduce the transmission of COVID-19 in the workplace.

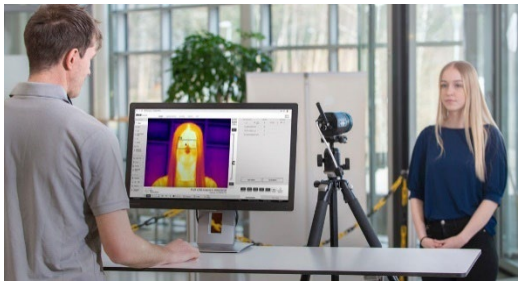
REFERENCE MATERIAL

- "What You Should Know About COVID-19 and the ADA, the Rehabilitation Act, and Other EEO Laws," US Equal Employment Opportunity Commission , https://www.eeoc.gov/wysk/what-you-should-know-about-covid-19-and-ada-rehabilitation-act-and-other-eeo-laws
- "The use of Thermography in Elevated Body Temperature Screening," Carol Chandler, https://irinfo.org/05-01-2016-chandler
- "ISO/TR 13145:2017 "Medical electrical equipment – deployment, implementation and operational guidelines for identifying febrile humans using a screening thermograph," International Organization for Standardization, https://www.iso.org/obp/ui/#iso:std:iso:tr:13154:ed-2:v1:en
- "Coronavirus (COVID-19) Update: FDA allows expanded use of devices to monitor patients' vital signs remotely," U.S. Food & Drug, https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-allows-expanded-use-devices-monitor-patients-vital-signs-remotely
- "Interim Guidance for Businesses and Employers to Plan and Respond to Coronavirus Disease 2019 (COVID-19)," CDC, https://www.cdc.gov/coronavirus/2019-ncov/community/guidance-business-response.html
- CDC guidance for Community Mitigation Strategies, https://www.cdc.gov/coronavirus/2019-ncov/downloads/php/open-america/community-mitigation-quicklinks.pdf

REFERENCE MANUFACTURERS

Bala is providing the following manufacturers to represent some of the various thermographic product categories that we examined. Each manufacturer provided detailed information on their platform, capabilities, limitations and pricing to inform various sections of this report.

- Individual capture system
  - Flir Exx-Series Handheld Units
  - Flir A400/A700 Smart Sensor
  - Future integrations into security platforms
  - https://www.flir.com/instruments/public-safety/environmental-health-and-safety/

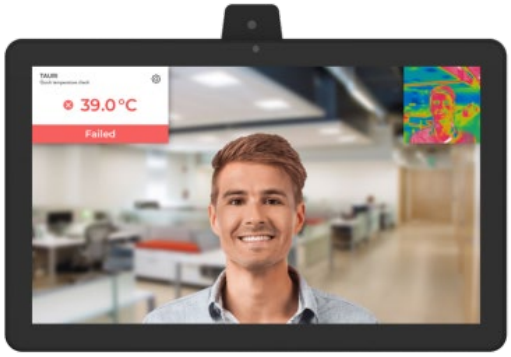


FLIR A400/700

- Group capture system
  - COHUHD Costar 3120HD group sensing system
  - Options for 15-30 person simultaneous detection
  - https://www.cohuhd.com/Product/octima-3210hd-series

COHUHD 3210HD

- Packaged sensor and display system
  - Aurora Tauri 10”, 15”, 21” panels
  - Future options for control system integrations and digital signage
  - https://auroramultimedia.com/tauri/



Aurora Tauri All-in-one