Bioload Exposure Metric Index (BEMI) – Phase One

BEMI focuses on reducing surface-related exposures, determined initially* through ATP sampling and averaging using a scientific method. Rather than dealing with many confusing ATP readings, the BEMI provides a single, at-a-glance metric that reflects average hygienic and cleaning levels, acting as a proxy for contaminants like organic, microbial, particulate, and chemical soils, much like CO_2 acts as a proxy for indoor air pollutants.

While such levels do not correspond in a linear way to pathogens or other pollutants, BEMI serves as a simple, applied science way to show, frame, and guide effective cleaning.

Phase one, completed in June 2026, provides practical sampling methods for BEMI. Phase two will define the BEMI 1-10 cleanliness scale based on field testing.

Why BEMI

Knowing surface exposure levels helps inform customer decisions, especially when cleaning healthcare, schools, or daycare facilities. BEMI Sampling Certification (Fig. 1), based on completion of knowledge and skills validation tied to Phases One and Two, complements exposure assessments through air sampling and other surveillance methods, and is part of the **Indoor Health Council™** Certified credential (Fig. 2) [Note credential logo designs are preliminary but representative] *As other methods are developed, these will be included in BEMI.

Figure 1

Figure 2

BEMI is an important metric for healthcare facilities as it enables better soil removal which helps remove pathogens, and better disinfection by removing bioload that interferes with many disinfectants.

BEMI also elevates the ATP luminometer from a bioload-level reader to a cleaning efficacy tester through a simple cleanliness scale which demonstrates the removal of many soils.

When we talk about "cleaning" a surface, we are talking about the **physical removal** of unwanted substances. A common misconception is that cleaning *kills* germs—that is *actually* the job of sanitizers and disinfectants. Cleaning simply lifts and washes them away, along with the organic "food" they need to survive (of course, remarkably, common soap is known to directly break down the cell walls of some pathogens).

Here is the breakdown of some specific soil, microbial, and chemical contaminants that proper cleaning removes from surfaces.

1. Soil Contaminants

In the cleaning industry, "soil" is broadly categorized by how it behaves chemically. Cleaning agents (like surfactants) are designed to break the bonds between these soils and the surface.

- **Organic Soils (Living or once-living matter):**
    - **Lipids and Fats:** Cooking oils, animal fats, sebum (natural skin oils), and grease.
    - **Proteins:** Blood, milk, egg residues, and skin flakes. Proteins are notoriously stubborn because they can coagulate and tightly bind to surfaces if exposed to heat.
    - **Carbohydrates:** Sugars, starches, and cellulose from spilled food or plant matter. They are generally water-soluble but become sticky and trap other dirt if left unchecked.

- **Inorganic Soils (Mineral-based matter):**
    - **Particulates:** Outdoor dirt, dust, silt, clay, and carbon soot from pollution or candles.

2. Microbial Contaminants

Cleaning does not necessarily neutralize microbes chemically, but the friction of wiping combined with soap or detergents physically detaches them from surfaces and partly removes them.

- **Bacteria:** Pathogens like *E. coli*, *Salmonella*, *Staphylococcus aureus* (Staph), and *Listeria*. Cleaning removes both the bacteria and the organic soils they feed on.
- **Viruses:** Both enveloped viruses (like Influenza and Coronaviruses) and tougher non-enveloped viruses (like Norovirus and Rhinovirus).
- **Fungi and Molds:** Mold spores, active mold growth (like *Aspergillus*), and yeasts.
- **Biofilms:** Biofilms are dense, protective "slimes" that colonies of bacteria build around themselves to hide from disinfectants. Physical cleaning is the only way to break this shield apart so that sanitizers can reach the bacteria underneath.

3. Chemical Contaminants

Surfaces easily become contaminated with chemical residues from human activity, outdoor tracking, or even the cleaning process itself.

- **Agrochemicals:** Residual pesticides, herbicides, and fertilizers tracked in from shoes or left on unwashed produce.
- **Industrial & Automotive Residues:** Motor oil, machine grease, lubricants, and volatile organic compounds (VOCs) that have settled out of the air.
- **Heavy Metals:** Microscopic metal particles.
- **Cleaner Residues:** Ironically, cleaning products themselves can become contaminants. If detergents and soaps are not properly rinsed, they leave behind a sticky surfactant film that acts like a magnet for new dirt and microbes.

Summary: How Cleaning Agents Tackle Common Contaminants

Contaminant Type	Primary Removal Mechanism	Ideal Cleaning Agent
Fats & Oils	Emulsification (breaking oil into tiny droplets)	Alkaline cleaners / Surfactants
Microbes & Biofilms	Physical detachment and suspension	Friction + Surfactants
Proteins	Digestion or breakdown	Enzymatic or highly alkaline cleaners

Phase One Sampling Method: Healthcare

Since healthcare facilities may present the greatest exposure risks, start with a simple sampling method for assessing cleaning in these critical environments.

Select high-touch surfaces and critical care areas, such as patient rooms and nurse stations (and or other locations per facility management), for routine sampling before and after cleaning procedures to measure the impact of cleaning interventions. (See “BEMI Phase One Sampling Plan Outline”)

1. Rotate sampling weekly across designated locations to ensure comprehensive coverage.

2. Thoroughly document all sampling, including location, time, surface type, cleaning process used, and personnel involved.

Expected Outcomes

1. Improved validation of cleaning protocols through objective, science-based metrics.

2. Actionable insights for reducing hospital-acquired infections and enhancing patient safety.

3. Development of best practices for cleaning and infection control, informed by robust data and collaborative expertise.

Important:

1. Use a single type of ATP monitor for consistency of ATP measurement.
2. Use a standardized swabbing method by being certified in ATP measurement. (Fig. 3). via the Indoor Health Council ATP Sampling Course. Without a consistent way of swabbing from place to place and worker to worker, the numbers become meaningless. Consistency in swabbing is key to effectiveness.

Figure 3

BEMI Phase One Sampling Plan Outline

1. Target Locations & Surface Selection

- High-Exposure Areas: Focus on critical care areas and high-touch surfaces, such as patient rooms and nurse stations, alongside any other locations designated by facility management.
- Weekly Rotation: Rotate sampling locations on a weekly basis to ensure comprehensive coverage across the facility.

2. Timeline and Frequency

- Intervention Testing: Conduct routine sampling both before and after cleaning procedures to accurately measure the factual impact of cleaning interventions.

3. On-Site Swabbing & Testing Protocol

- Standardized Swabbing: Have an ATP Sampling Certified technician rub a specialized swab across a standard surface area, typically measuring 10 cm x 10 cm (a 4-inch square) of the surface.
- Reagent Activation: Insert the swab into its plastic sleeve and snap the handle to release a liquid reagent containing luciferin and the enzyme luciferase.
- Luminometer Reading: If ATP is present, it will trigger a faint chemical glow. Place the swab inside a handheld luminometer, which measures the light intensity and instantly translates it into a score of Relative Light Units (RLUs).

4. Quality Control & Quality Assurance

- Equipment Standardization: Use a single type of ATP monitor exclusively to ensure consistency across all ATP measurements.
- Personnel Certification: Ensure all operators are fully certified in ATP measurement to maintain a strictly standardized swabbing method.

5. Mandatory Documentation

To properly validate protocols, thoroughly document the following details for every single sample taken:

- Location of the test.
- Time the sample was gathered.
- Surface type that was swabbed.
- Cleaning process utilized prior to the post-clean test.
- Personnel involved in the sampling and cleaning.

Why this matters: Because a surface can look visually spotless and still be covered in biological matter, this data-driven approach moves past the "looks clean" eyeball test to objectively prove whether a surface is genuinely clean.

ATP Levels Monitoring Log

Date: _________________

Luminometer Model/Serial #: _________________

1. Personnel Involved

◯ Sampling Conducted By: ______________________________

◯ Cleaning Performed By: ______________________________

2. Sample Details

◯ Time of Collection: _______________

◯ Location / Zone: ___________________________________

(e.g., Office #1, Cafeteria)

Specific Surface Swabbed: ______________________________

(e.g., Desktop, Doorknob, Table)

3. Surface & Cleaning Context

◯ Surface Material / Type:

◯ Stainless Steel

◯ Plastic

◯ Polymer

◯ Rubber

◯ Ceramic / Tile

◯ Other: _______________

◯ Cleaning Process Utilized:

____

4. Test Results (For Internal Records)

RLU Reading

◯ Pre-Clean (Required) ____

◯ Post-Clean (Required) ____

Verification Sign-off: _____________________________ Date: _______________

Quick Tips:

* Don't touch the swab tip: Ensure hands or gloves never touch the sampling bud to avoid cross-contamination.

* Consistency matters: Always swab a standard area using a crisscross pattern for accurate Relative Light Unit (RLU) comparisons.

Hand Hygiene Certification

Using ATP (Adenosine Triphosphate) bioluminescence to check hands for contamination is a rapid way to verify handwashing effectiveness. Since ATP is present in organic matter (bacteria, food residue, human skin cells), a high reading means the hands are not truly clean.

To get accurate, repeatable results, your swabbing technique needs to be consistent. Here is the step-by-step protocol to ensure you are capturing a representative sample.

The ATP Hand Swabbing Protocol

1. Preparation

- Do not touch the swab tip: Ensure your own hands are clean, or wear sterile, ATP-free gloves before handling the testing kit.
- Check the swab: Remove the swab from the outer tube. If the kit requires pre-moistening (and does not come pre-wetted), dip it into the supplied compensating buffer.

2. The Swabbing Technique (The "Z-Pattern & Rotate")

You want to target the areas of the hand most likely to harbor cross-contamination: the palms, fingertips, and between the fingers.

- Step 1: The Palm Pressing firmly enough to create a slight bend in the swab shaft, sweep the swab across the palm of the dominant hand in a tight "Z" or zigzag pattern.
- Step 2: Rotate the Swab As you move across the hand, slowly rotate the swab shaft between your thumb and forefinger. This ensures the entire 360-degree surface of the swab tip collects the sample, rather than just rubbing one side clean.
- Step 3: Fingers and Webs Streak the swab down the length of each finger, pay special attention to the webbed spaces between the fingers, and thoroughly swab

the fingertips and under the fingernails (where the highest concentration of transient bacteria usually hides).

Crucial Tip: Maintain consistent pressure. You are not just dusting the surface; you need enough friction to pick up microscopic organic residues.

Getting certified in Hand Hygiene (Fig. 4) is part of the BEMI Sampling Certified and **Indoor Health Council™** Certified credentials (Fig. 1 & 2) and based on the Indoor Health Council clean hands training.

Figure 4

Clean Tools Certificate (CTC)

Clean Tools Certification (Fig. 5) is a prerequisite for BEMI Sampling Certified and **Indoor Health Council™** Certified credentials (Fig. 1 & 2). There are two components:

1. Pristine visual appearance of tools (verified by photos of tools and cleaning closets)
2. Passing BEMI scores for touch points (e.g., mop and equipment handles, levers, or controls).

Figure 5

Definitions

ATP

In professional cleaning, healthcare, and food industries, **ATP** stands for **Adenosine Triphosphate**. It is the universal energy molecule found in all living or once-living things—including bacteria, mold, human skin cells, bodily fluids, and food residue.

If a surface looks visually spotless, it could still be covered in biological matter. **ATP testing** acts as an objective, invisible detector, giving cleaning teams a data-driven way to prove whether a surface is genuinely clean or just "looks" clean.

How the ATP Test Works

The scientific mechanism behind an ATP test is borrowed directly from nature. It relies on **bioluminescence**—the same chemical reaction that causes fireflies to glow.

Here is how the sampling process works on-site:

1. **Swabbing:** A technician rubs a specialized swab across a standard area (usually a 10 cm x 10 cm – 4-inch square) of a recently cleaned surface.
2. **Activation:** The swab is inserted into its plastic sleeve, and the handle is snapped to release a liquid reagent containing **luciferin** and the enzyme **luciferase**.
3. **The Glow:** If ATP is present on the swab, it acts as a fuel source, triggering a faint chemical glow.
4. **The Reading:** The swab is placed inside a handheld device called a **luminometer**. The device measures the intensity of the light and instantly translates it into a score measured in **RLUs (Relative Light Units)**.

Luminometer

A **luminometer** is a sensitive scientific instrument used to measure the intensity of light emitted from a chemical or biological reaction. By mixing a surface swab with luciferase, a luminometer can instantly detect ATP. **More light = more contamination.**

Bioload

In the world of cleaning, infection control, and sterilization, **bioload** (often referred to interchangeably with **bioburden**) is the total amount of organic matter including but not limited to living microorganisms—bacteria, fungi, viruses, and spores—contaminating an object or surface *before* it undergoes disinfection.

Think of bioload as the actual "enemy forces" on a surface, while the ATP testing is a scout report that estimates how large those forces might be based on the organic matter they leave behind.

Why Bioload is the Ultimate Enemy of Disinfectants

You cannot effectively disinfect a surface without drastically reducing the bioload first. Trying to disinfect a surface with a high bioload is like trying to paint over a muddy wall—it just will not stick. Here is why:

- **The "Shielding" Effect:** Microorganisms do not just sit exposed on a surface; they bury themselves under layers of dead cells, dust, proteins, and fats. If you apply a disinfectant directly onto a heavy bioload, the chemical is often consumed by the top layer, leaving the microbes underneath untouched.
- **Chemical Neutralization:** Many common disinfectants, especially bleach (sodium hypochlorite), actively react with organic matter. High bioload rapidly degrades and neutralizes the chemical strength of a disinfectant before it can do its job.
- **Biofilm Formation:** If a high bioload is left unmanaged, bacteria can bind together to form a **biofilm**—a slimy, protective matrix that is up to 1,000 times more resistant to disinfectants than individual bacteria.

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BEMI Phase Two Preview - Healthcare Facilities

Hospital-acquired infections (HAIs) continue to present significant challenges to patient safety and healthcare quality. Enhanced cleaning practices and validated measurement tools are critical in reducing HAI rates. BEMI offers a novel and standardized approach for assessing bioload exposure in healthcare environments. The BEMI Localized Verified Exposure (LOVE) index provides an area or location-based, quantitative evaluation of cleaning efficacy using a 1-10 scoring metric.

BEMI Healthcare Objectives

1. To reduce hospital-acquired infections by improving the measurement and validation of cleaning practices.

2. To correlate BEMI scores with adenosine triphosphate (ATP) sampling, heterotrophic plate counts, and other established scientific methods.

3. To evaluate the effectiveness of the LOVE index in validating cleaning protocols across different facility areas using a standardized 1-10 scoring system.