

A technical paper for food processors

Onsite Hypochlorous Acid Generation in Food Processing

FCN 1811, PNC 2800, what the research actually supports, and what switching costs

What this paper does and does not claim

An EcoloxTech system is a **device that produces a hypochlorous acid solution on site**. It is regulated by the EPA as a device, it is not a registered disinfectant, and we make no efficacy claims for it or for the solution it produces.

Regulatory authorisation and efficacy are different things. This paper's central subject is an FDA Food Contact Notification, which authorises a use. It is not a performance claim, and we do not present it as one.

Research is reported as findings about hypochlorous acid and electrolysed water under the conditions the authors tested, cited to the publication. **It includes the studies that found little or no effect**, because those describe the operating conditions that matter most in a real plant.

Cost figures are EcoloxTech's own field-reported data, labelled as such. They are not independently audited.

We do not claim that our equipment prevents outbreaks or recalls. What we can evidence is what is authorised, what the literature found at the authorised concentrations, and what the cost categories are.

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1. The two questions that stall the decision

A processor weighing a switch to hypochlorous acid asks the same two things first: *is this authorised for use on my product*, and *what will getting that authorisation cost me in time, fees and legal risk?* For a plant using an EcoloxTech generator, both questions already have documented answers, and that is the substance of this paper.

Food Contact Notification (FCN) 1811, effective since 2017, authorises electrolytically generated hypochlorous acid as an antimicrobial processing aid for meat and poultry, fish and seafood, fruits and vegetables, and shell eggs. In June 2022, in response to a Pre-Notification Consultation filed by EcoloxTech (PNC 2800), the FDA's Division of Food Contact Substances confirmed in writing that hypochlorous acid generated on site by an EcoloxTech machine is already covered by FCN 1811, and that a customer using that machine for the specified intended uses may market and use the resulting food contact substance without filing a notification of its own.

That second letter is the part worth understanding, because it removes a cost most processors never budget for.

2. What FCN 1811 actually authorises

FCN 1811 is EcoloxTech's own notification. It became effective on **13 October 2017**, following the agency's Environmental Decision Memo of 5 October 2017, and appears in the FDA's Inventory of Effective Food Contact Substance Notifications. It authorises hypochlorous acid (CAS Reg. No. 7790-92-3) as an antimicrobial agent in aqueous solution for four specific uses, with free available chlorine **not exceeding 60 ppm**.

Authorised use	Ceiling	After treatment
Spray, wash, rinse, dip, chiller or scalding water for whole or cut meat and poultry, including carcasses, parts, trim and organs	60 ppm under the FCN; 50 ppm for these uses under FSIS Directive 7120.1	No drain or rinse condition
Process water, ice or brine for washing, rinsing or cooling processed and pre-formed meat and poultry products	60 ppm under the FCN; 50 ppm for these uses under FSIS Directive 7120.1	Ready-to-eat meats: either a 10-minute drain step or a potable water rinse
Process water or ice for washing, rinsing or cooling fruits, vegetables, and whole or cut fish and seafood	60 ppm	Required for fruits and vegetables, and for fish and seafood intended to be consumed raw: either a 10-minute drain step or a potable water rinse
Process water for washing or rinsing shell eggs	60 ppm	No drain or rinse condition

Ceilings and conditions as stated in the FDA's inventory entry for FCN 1811. The meat and poultry terms are further codified in USDA FSIS Directive 7120.1, Table 2, which sets 50 ppm for those uses and a chiller dwell time of 10 seconds to 120 minutes. Where this paper and the notification differ, the notification governs — read it.

Be precise about what that ceiling governs

Hypochlorous acid, like conventional chlorine, can be generated and dosed well above these figures for general antimicrobial water treatment, and processors have run chlorinated chiller and wash water across a range of

concentrations for decades. What FCN 1811 authorises is narrower and more valuable: HOCl at or below these ceilings as a **food-contact processing aid that needs no further FCN authorisation**, and, for the uses that carry no drain or rinse condition, no follow-up step. A generator can be run harder for other purposes in a plant, but that use sits outside FCN 1811's coverage and outside the benefits described here.

Note the drain-or-rinse condition carefully. It is often summarised as applying only to produce and to raw-consumed seafood. The FDA's own inventory entry also lists **ready-to-eat meats**, and it offers a **10-minute drain step as an alternative to the potable water rinse** — which is frequently the cheaper and simpler of the two to build into a line. Check your own use against the notification text rather than against a summary of it, including this one.

3. What PNC 2800 added, and why it matters commercially

Two documents, two different jobs — worth getting right

FCN 1811 is the authorisation. It is a Food Contact Notification, effective since 13 October 2017, and in its 2022 correspondence the FDA records the Manufacturer/Supplier as EcoloxTech, Inc. This is the instrument that makes the use lawful.

PNC 2800 is not a second notification. It is the FDA's response to a Pre-Notification Consultation — a letter confirming that the substance produced by an EcoloxTech machine *is already authorised by FCN 1811*, and that the customer operating that machine may market it without further authorisation under an FCN.

The two only work together. The letter has force because the notification exists; the notification reaches your plant because of the letter. Anyone describing PNC 2800 as the authorisation, rather than as the letter that extends an existing one to you, has it the wrong way round.

An effective FCN authorises a specific manufacturer's substance for a specific use. On its own it does not automatically extend to every downstream buyer who independently generates the same chemistry. That ambiguity is what EcoloxTech asked the FDA to resolve on 23 May 2022: does a processor who buys and operates an EcoloxTech on-site generator need to file its own FCN, or does FCN 1811 already cover the substance produced by that machine?

The answer came on **6 June 2022**, in a signed letter from the Division of Food Contact Substances, Office of Food Additive Safety, in the FDA's Center for Food Safety and Applied Nutrition. The operative sentences are worth quoting rather than paraphrasing:

FDA, Pre-Notification Consultation (PNC) 002800, 6 June 2022

“Based on the information you provided, it is our opinion that this FCS and intended use are **already authorized by effective FCN 1811** when the FCS is generated on-site by the same machine manufactured or supplied by EcoloxTech.”

“When utilizing a machine supplied by EcoloxTech to produce the FCS, **you may market this FCS for the intended use, in compliance with applicable limitations and specifications in FCN 1811, without further authorization under an FCN.**”

In the same letter the FDA sets out the terms of FCN 1811 and records the **Manufacturer/Supplier as EcoloxTech, Inc.**

Two things about that letter are worth drawing out. It is addressed to the processor's position, not ours — the phrase is *you may market this FCS*, meaning the customer operating the machine. And it is an opinion of the agency's own Division of Food Contact Substances, not a reading by a supplier's marketing department. If your regulatory team wants to see it, ask us and we will send the signed letter.

What that is worth in practice

A new FCN requires FDA review of a complete safety and technical data package. By regulation the agency's review period runs up to **120 days from a complete filing** before an uncontested notification becomes effective — and assembling the underlying toxicology, migration and identity data behind a first-time filing is a multi-year undertaking before the clock even starts. FCN 1811 itself dates to a 2017 filing.

A plant installing an EcoloxTech generator inherits an already-effective federal authorisation rather than opening a process of its own. That is a direct, quantifiable avoidance of legal, consulting and delay cost — and it is something an on-site generator without an equivalent FCN and PNC cannot offer.

4. Two authorities, two ceilings — do not mix them up

The commonest compliance finding we see in food plants is a single site-wide ppm figure written into every procedure. By definition that figure is wrong somewhere, because food contact and food-contact *surfaces* are governed by different authorities with different limits.

	FCN 1811	21 CFR 178.1010
What it covers	Hypochlorous acid in or on the food itself — process water, ice, brine, chiller, wash, spray, dip	Sanitising solutions on food-contact <i>surfaces</i> — equipment, tables, conveyors, utensils
Ceiling	50 ppm meat and poultry; 60 ppm produce, seafood, shell eggs	Up to 200 ppm available chlorine
After treatment	Potable rinse for produce and for raw-consumed seafood; none for meat, poultry, shell eggs at these concentrations	Adequate draining

Write the applicable limit into each SSOP and name the authority it comes from. An auditor who asks “under what authority?” should get a citation, not a number.

5. What the research shows at these concentrations

A great deal of the published electrolysed-water literature tests 100–250 ppm and higher, to establish the outer bactericidal limits of the chemistry. Those conditions fall outside what FCN 1811 authorises. **The studies below were selected because they test at or below the relevant ceiling**, so the research described matches what the notification actually permits rather than exceeding it.

Meat and poultry — 50 ppm

- Park, Hung & Brackett (2002, *International Journal of Food Microbiology*): electrolysed water with 50 mg/L residual completely inactivated *Campylobacter jejuni* in pure culture within 10 seconds, and reduced *C. jejuni* by roughly 3 log₁₀ CFU/g on actual chicken meat, against 1 log₁₀ from a deionised-water wash at the same conditions.
- Ding, Rahman, Purev & Oh (2010): on beef, slightly acidic electrolysed water at just 5 mg/L available chlorine (pH 6.2) produced a 1.72 log₁₀ reduction of *E. coli* O157:H7 with a short immersion.
- Tango et al. (2014, *Journal of Applied Microbiology*, and a companion pork study): slightly acidic electrolysed water at 5–30 ppm combined with a mild fumaric acid dip acted synergistically against *E. coli* O157:H7, *Salmonella* Typhimurium and *Listeria monocytogenes* while extending shelf life, with electrolysed water alone reaching complete inactivation at 20 ppm applied at 40°C for three to five minutes.

Seafood and fish — 60 ppm

- Slightly acidic electrolysed water at 60.33 mg/L available chlorine completely inactivated *Listeria monocytogenes* on food-contact surfaces within 30 seconds, matching a sodium hypochlorite solution at the

same concentration (*Food Quality and Safety*).

- Quan et al. (2010): strong bactericidal activity against *Vibrio parahaemolyticus* and *Vibrio vulnificus* — the two organisms of greatest concern in raw and undercooked seafood — outperforming sodium hypochlorite at matched available chlorine in laboratory broth systems.
- **On the product itself the picture is more modest.** Acidic electrolysed oxidising water applied to raw fish surfaces produced 1.1–1.3 log₁₀ reductions of *Listeria*, against the near-complete kill seen on clean equipment surfaces.

Fruits and vegetables — 60 ppm

This is where the evidence at or below the ceiling is strongest, and where it shows direct product efficacy rather than only equipment efficacy.

- A 2026 study in *Foods* tested acidic HOCl at exactly 30 ppm and 60 ppm — the low end and the ceiling of the authorised range — against total microbial count, *E. coli* and *Listeria monocytogenes* on chives and green onions, reporting high efficacy at both, with background counts on treated green onions falling below the level of detection.
- Ogunniyi et al. (2021, *Food Microbiology*): on baby spinach, pH-neutral electrolysed oxidising water at 50 ppm and 85 ppm significantly reduced total bacterial load compared with untreated or tap-water-rinsed leaves, and outperformed a 50 ppm commercial peracetic-acid-based sanitiser by roughly tenfold in one controlled comparison.
- Torlak (2014, *International Journal of Food Microbiology*): on apples, neutral electrolysed water at 50 ppm free available chlorine reduced *Alicyclobacillus acidoterrestris* spores — a spoilage organism used as a standard test organism for produce sanitiser efficacy — by approximately 2.0 log₁₀ per apple after one minute.

Shell eggs — 60 ppm

Published work on slightly acidic electrolysed water containing as little as 4 mg/L available chlorine reports complete inactivation of *Salmonella* Enteritidis on the eggshell within two minutes, and a related study reports a 6.5 log₁₀ reduction using 15 mg/L over three minutes. Both are a small fraction of the 60 ppm ceiling, which means an egg processor operating inside the authorised range has considerable headroom above the concentrations the literature already found effective — a margin rather than a limit.

6. Where it does not work, and why that matters more

Results are not uniform, and the exceptions are the most useful part of this literature, because they describe the plant conditions that decide whether any of the above transfers to your operation.

- **Chlorine demand can swamp the dose.** Veasey & Muriana (2016, *Foods*) found that a typical loaded poultry chiller carries a chlorine demand of **1,000–2,000 ppm**, which 50 ppm in the make-up water cannot fully overcome.
- **On heavily soiled product, the effect can vanish.** The same work found that spraying raw pork bellies with electrolysed water at roughly 50 ppm free available chlorine showed **no significant reduction** in *Salmonella* or *Listeria* against a water-only control.
- **Field conditions differ from laboratory conditions.** A field trial of poultry carcasses at EU-permitted chlorine levels found **less than a 0.3 log₁₀ reduction** in *Campylobacter* under some plant operating conditions.
- **Clean equipment behaves very differently from soiled product.** Slightly acidic electrolysed water at 50–200 mg/L measured *Listeria monocytogenes* reductions of 2.3 to more than 5.6 log₁₀ on stainless steel meat-contact surfaces — far more consistent than the same chemistry on meat.

The pattern across all of it is consistent, and it is the honest conclusion to draw: efficacy at or below the 50 ppm meat and poultry ceiling depends heavily on the organic load on the surface, the pH and oxidation-reduction potential of the solution *as actually generated and maintained*, contact time, and whether the treatment is paired with a mild acid or a pre-rinse step to cut organic demand.

Read together, this research supports FCN 1811's actual scope — chiller, scald, wash and equipment-contact water, generated and maintained at the specified concentration and chemistry — considerably more than it supports treating any 50 ppm HOCl spray as a guaranteed stand-alone kill step regardless of how it is generated, applied or maintained. Any supplier who tells you otherwise is selling past the evidence.

7. What contamination costs, and what switching saves

The economic case starts with the documented cost of failure. The USDA's Economic Research Service estimated the cost of 15 major foodborne illnesses in the United States at **\$17.6 billion in 2018**, up from \$15.5 billion in 2013 after adjusting for inflation and income growth. Broader estimates using a different methodology put the total figure substantially higher, in the region of \$75 billion, with nontyphoidal *Salmonella* alone accounting for a large share.

At company level, a 2011 Grocery Manufacturers Association study found the average food recall costs approximately **\$10 million in direct expenses**, with 52 per cent of companies experiencing a major recall reporting total financial impact above \$10 million, and one in twenty exceeding \$100 million once indirect costs — business interruption, lost contracts, litigation, insurance — are included. The 2009 Peanut Corporation of America *Salmonella* recall is estimated to have cost US peanut producers roughly \$1 billion in lost production and sales industry-wide.

Those figures do not depend on any sanitiser choice. They establish the scale of loss that better pathogen control is worth protecting against, and nothing more.

EcoloxTech's field-reported cost accounting

Separately from those industry figures, EcoloxTech publishes its own field-reported cost accounting for facilities that have converted from legacy chemical sanitation — quats, peracetic acid, chlorine dioxide, bleach — to on-site HOCl generation. **These are company-reported figures, not independent academic research, and they are presented here as exactly that.** They are itemised against real, auditable cost categories that any plant controller can check against their own invoices.

Cost category	Before (monthly)	After (monthly)	Monthly saving
Chemical spend (quats / PAA)	\$8,500	\$800	\$7,700
Rinse water and wastewater fees	\$2,100	\$300	\$1,800
PPE and safety equipment	\$1,200	\$100	\$1,100
Equipment corrosion repairs	\$1,500	\$250	\$1,250
Sanitation labour overtime	\$3,400	\$1,400	\$2,000
Failed swab re-cleans	\$1,000	\$0	\$1,000
Total	\$17,700	\$2,850	\$14,850

EcoloxTech field-reported figures for a mid-size processor running a commercial-scale generator. Company-reported, not independently audited.

That is an annualised net saving above **\$178,000** from a single generator, against commercial units ranging from roughly \$5,000 to \$25,000 depending on output capacity — a payback the company reports at one to three months. Three facility-reported cases are consistent with that model:

Facility	Reported monthly saving	Payback	What changed
Seafood plant, Florida	\$12,000	about 7 weeks	Replaced ozone fogging and quat sprays
Produce packhouse, California	\$5,300	about 60 days	Cut rinse water, PAA and PPE spend; swab failures to zero
Cheese processing, Michigan	\$19,200	not disclosed	Replaced quats; eliminated about 2 hours a day of rinse downtime

Results will vary with chemical mix, facility size, water and labour rates and local utility costs. **Treat the categories in the first table, not the dollar figures, as the checklist** — chemical purchasing, water and effluent, PPE and training, equipment corrosion, and sanitation labour hours are the five places on any plant's ledger where on-site generation displaces a recurring cost with a one-time equipment investment. Then run the arithmetic on your own last twelve months of invoices.

8. The wider regulatory position

- **EPA tolerance exemption.** The EPA has exempted the antimicrobial pesticide ingredient hypochlorous acid from the requirement of a tolerance when applied to food-contact surfaces in public eating places (Federal Register, 14 September 2022). That addresses the surface-sanitising side of a plant's operations, which is separate from the direct food-contact uses FCN 1811 governs.
- **Organic production.** Electrolysed water is accepted for USDA organic production and handling, unlike quaternary ammonium compounds and chlorine dioxide, which are restricted or disallowed in organic contexts. For processors supplying organic, antibiotic-free or “clean label” retail programmes, that is a live commercial consideration rather than a technicality.
- **USDA FSIS.** The meat and poultry terms of FCN 1811 are codified in FSIS Directive 7120.1, Table 2, so the inspector's reference and the notification agree.

Taken together with FCN 1811 and PNC 2800, a processor adopting an EcoloxTech generator is working inside a documented, multi-agency regulatory footprint rather than assembling compliance justifications on its own.

9. Where our registered product fits — and where it does not

This distinction is worth stating clearly, because blurring it is the commonest way a well-run programme acquires a compliance problem.

	On-site generated HOCl	HOCl-AS200
What it is	Solution produced by an EcoloxTech device. The device is an EPA device and carries no efficacy claims.	An EPA-registered antimicrobial pesticide, EPA Reg. No. 101112-1, label accepted 10 December 2025.
Authority for food contact	FCN 1811, at the ceilings in section 2, plus 21 CFR 178.1010 for food-contact surfaces.	None. AS200 is not a food-contact authority and must not be used as one.
What it may claim	Nothing. It is a device output; research is research.	Exactly the organisms on the accepted label, at a five-minute contact time, on precleaned hard non-porous surfaces.
Typical role in a plant	Process water, ice, chiller, wash, and volume surface work.	Where a documented disinfection claim against a named organism is required.

In short: the notification authorises a *use*; the registration supports a *claim*. A plant usually needs both, in different places, and the SSOP should say which is which.

10. What on-site generation does not fix

- **It does not replace cleaning.** Every result in section 5 that held up was on a surface where organic load had been dealt with first. Section 6 is what happens when it has not been.
- **It is not a stand-alone kill step** on heavily soiled product, and the literature says so directly.
- **It does not change your HACCP or preventive controls plan.** It is an input to it. Validation, monitoring, corrective action and verification remain yours.

- **It introduces a maintenance obligation.** You swap a chemical supply chain for cells, membranes and control boards. Hold critical spares, and treat the generator as plant with a maintenance schedule, not an appliance.
- **It needs feed water of a known quality** and consistent power. A site with marginal water treatment has a prerequisite to resolve first.
- **Measurement moves to the point of use.** Strength at the generator is not strength in a loaded chiller. Measure in the water, with the product in it, on a schedule, and log it.

11. Questions to ask any supplier, including us

- **Under what authority is this use permitted on my product?** Ask for the FCN number or the CFR citation, not a reassurance.
- **Does that authorisation extend to me as the operator,** or only to the manufacturer of the substance? Ask to see the letter.
- **What ceiling applies to each use in my plant** — product contact versus equipment surfaces — and which rinse requirements come with each?
- **Is that figure a claim or a study?** If it comes from research, ask for the publication, the organism, the concentration, the soil load and the contact time.
- **What is the chlorine demand of my application,** and how was the set point chosen against it?
- **How is concentration verified at the point of use,** how often, and what is the corrective action when it is out of range?
- **What does your equipment not solve?** A supplier with no answer has not thought about your plant.

Sources

- US FDA, Center for Food Safety & Applied Nutrition, Office of Food Additive Safety, Division of Food Contact Substances. Signed response letter, Pre-Notification Consultation (PNC) 002800, to EcoloxTech, Inc., **6 June 2022** (responding to a request of 23 May 2022). Quoted directly in section 3; available on request.
- US FDA. Environmental Decision Memo, Food Contact Notification No. 1811, 5 October 2017; and Inventory of Effective Food Contact Substance Notifications, FCN 1811.
- USDA FSIS Directive 7120.1, Table 2, “Safe and Suitable Ingredients Used in the Production of Meat, Poultry, and Egg Products.”
- Park, C.M., Hung, Y.C. & Brackett, R.E. (2002). *International Journal of Food Microbiology* 72(1–2), 77–83.
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- “Effect of Electrolyzed Water on Campylobacter Numbers on Poultry Carcasses Under Practical Operating Conditions at Processing Plants.” *Food Control*.
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- “Bactericidal Efficacy of Slightly Acidic Electrolyzed Water Against *Listeria monocytogenes*.” *Food Quality and Safety*, fyab038.
- Quan et al. (2010), on slightly acidic electrolysed water against *Vibrio* species, as cited in *Food Control* reviews of electrolysed water in seafood applications.

- “Evaluation of the Disinfection Capacity of Electrolyzed Water ... on Chives at Different Storages.” *Foods* (2026), doi.org/10.3390/foods15050957.
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- Torlak, E. (2014). *International Journal of Food Microbiology* 185, 69–72.
- Eggshell studies on neutral and slightly acidic electrolysed water, PMC6657710 and related *Salmonella* Enteritidis work (4–15 mg/L available chlorine).
- USDA Economic Research Service, “Cost Estimates of Foodborne Illnesses” and “Updating Economic Burden of Foodborne Diseases Estimates for Inflation and Income Growth.”
- Grocery Manufacturers Association (2011) food recall cost study.
- EPA. Hypochlorous Acid; Exemption From the Requirement of a Tolerance. *Federal Register*, 14 September 2022.
- EcoloxTech field-reported cost data and facility case results (company-published).

A note on how to use this paper

The regulatory citations above are the load-bearing part of this document. Before you rely on any of them in your own food safety plan, read the primary text — the notification, the directive, the CFR section — rather than our summary of it. We would rather you checked.

We are not your regulatory counsel and this is not legal advice.