

Cold Chain Operating System

A modern field library for shippers and reefer brokers: temperature, humidity, ethylene, mixed loads, and claims — distilled from USDA AH-66 and Handbook 669 into practical decision rules with free interactive tools.

ProspectSentinel

~14 min read

USDA AH-66 + HB 669

For shippers & reefer desks

Cold Chain Index

Transit Guide

Precool Estimator

Claim Analyzer

PACA Calculator

Rate Explorer

Claim package checklist

FOR SHIPPERS & REEFER BROKERS

Why this library exists

Two public USDA handbooks already encode most of what a produce desk needs to know about cold chain: **Agriculture Handbook 66 (AH-66, 2016)** on commercial storage, and **AMS Handbook 669** on protecting perishable foods during truck transport. Together they exceed **890 pages**. They are excellent — and almost unusable as daily tools.

ProspectSentinel / Sentinel Labs built interactive tools from those sources (commodity matrices, co-load checks, precool math, claim support). This **Cold Chain Field Library** is the narrative layer: modernized white papers that teach the decision system and link into the tools at the moment of need.

Audience: produce and cold-chain **shippers** (QC, dock, logistics) and **reefer brokers** who quote, cover, and defend loads. Not a substitute for your receiver's PO specs — a shared language for why those specs exist.

Three levers that govern shelf life

1 · TEMPERATURE

Dominant lever
Respiration $\approx 2\times / 10^{\circ}\text{C}$

2 · HUMIDITY

Water loss control
Most produce 90–95% RH

3 · ATMOSPHERE

O₂ / CO₂ / ethylene
CA · MAP · venting

Commercial rooms and reefers typically hold only about $\pm 1^{\circ}\text{C}$ — USDA setpoints are safe limits, not lab precision targets (AH-66).

The operating system in one screen

1. **Temperature** dominates shelf life. Respiration and many deterioration processes roughly double for every 10 °C rise (AH-66 framing). Abuse is additive across dwell, transit, and unload (HB 669).
2. **Cold is not universally safe.** Chilling injury damages many tropical/subtropical crops at temperatures still above freezing.
3. **Ethylene separates loads.** High producers cannot casually ride with greens, cole crops, and many flowers.
4. **Transit $\neq$ storage.** Handbook 669 often sets practical transit bands and ice rules that differ from long-term storage optima in AH-66.

5. **A reefer maintains; it does not precool at capacity.** Field heat is a dock problem first.
6. **Five factors for mixed loads:** temperature, RH, ethylene, odor pairing, and modified-atmosphere needs — formalized as USDA Groups 1–8.

Use the tools while you read. [Cold Chain Index](#) for commodity physics and co-load; [Produce Shipper Transit Guide](#) for dock setpoints/mix/checklist; [Reefer Precool Time Estimator](#) for cool-down realism; [Perishable Claim Analyzer](#) and [PACA Good Arrival Calculator](#) when quality becomes a dispute.

USDA physics vs federal rules (eCFR)

This library teaches **commodity and reefer physics** from public USDA handbooks. Selected **federal regulations** on [eCFR.gov](https://www.ecfr.gov) set a separate *legal floor* for produce trade practice and freight claims. Use both — they answer different questions.

QUESTION	START HERE	PUBLIC SOURCE
What temperature / mix / precool does the crop need?	This Field Library + tools	USDA AH-66 · HB 669
What does PACA regulate for produce dealers?	PACA Good Arrival Calculator	7 CFR Part 46 · § 46.44
How are interstate motor carrier loss/damage claims investigated?	Claim package checklist · Deadline calculator	49 CFR Part 370

Not legal advice. eCFR text changes. Contracts, bills of lading, and insurance policies can impose shorter deadlines or different procedures. Confirm the current regulation and your paperwork.

Series map

#	WHITE PAPER	JOB TO BE DONE
01	The Reefer Is Not a Precooler	Stop loading field heat
02	Colder Is Not Safer	Set floors, not “as cold as possible”
03	Ethylene: The Invisible Load Killer	Separate producers & sensitives
04	USDA Groups 1–8	Official co-load playbook
05	Airflow & Load Patterns	Make setpoints real in the box
06	Commodity Setpoint Desk Guide	Transit vs storage temps
07	Protein, Dairy & Eggs	Beyond produce odor & temp rules
08	CA, MAP & Gas	When atmosphere extends life
09	From Temperature Log to Claim	Evidence + PACA intersection
10	Seasonal Produce Desk	Peaks, capacity, rates + physics

How shippers and brokers should use this

Shipper dock / QC

- ☐ Confirm pulp temp vs transit band before release ([Produce Shipper Transit Guide](#), [Reefer Precool Time Estimator](#)).
- ☐ Run mix check when more than one commodity shares air ([Cold Chain Index](#), [Produce Shipper Transit Guide](#) Mix tab).
- ☐ Photograph product, pulp probes, and reefer setpoint/return air at seal.
- ☐ Treat top-ice and SO₂/grape fumigation rules as hard constraints, not preferences.

Broker / coverage desk

- ☐ Write setpoints and "no mix with..." on the rate con in commodity language, not vibes.
- ☐ Flag multi-temp when groups conflict; price the equipment you actually need.
- ☐ When a claim appears, reconstruct the timeline before arguing the photo ([Perishable Claim Analyzer](#), [PACA Good Arrival Calculator](#)).
- ☐ Use seasonal rate context without forgetting physics ([Produce Truck Rate Explorer](#)).

[Open Cold Chain Index](#)

[All Sentinel Tools](#)

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FAQ

- ▶ Is this official USDA guidance?
- ▶ Can I share these with customers?
- ▶ Where are the interactive tools?

Sources & interactive tools

- [USDA AH-66 — The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks \(2016\)](#).
- [USDA AMS HB 669 — Protecting Perishable Foods During Transport by Truck](#)
- **Federal rules (eCFR):** [7 CFR Part 46 — PACA regulations](#) · [49 CFR Part 370 — Principles and practices for the investigation and voluntary disposition of loss and damage claims](#)
- [Cold Chain Index](#) — 200+ commodity storage/transit matrix + co-load checker
- [Produce Shipper Transit Guide](#) — dock setpoints, mix load, checklist
- [Reefer Precool Time Estimator](#) — half-cooling-time style estimator
- [Perishable Claim Analyzer](#) · [PACA Good Arrival Calculator](#) · [Produce Truck Rate Explorer](#)
- [Freight claim package checklist](#) · [Claim / Carmack deadline calculator](#)

IMPORTANT NOTICE

This publication modernizes and explains **public USDA guidance** and, where noted, points to **public federal regulations on eCFR.gov** for educational use by shippers, brokers, carriers, and operators. It is **not** an official USDA or DOT document, and it is **not** legal, insurance, PACA advocacy, food-safety certification, or professional claims advice. Always verify current commodity specifications, contracts, and the *current* eCFR text with the controlling authority and your counsel.

Primary sources: USDA-ARS Agriculture Handbook 66 (2016); USDA-AMS Handbook 669, *Protecting Perishable Foods During Transport by Truck* (1995, reprinted 2008), including Load Compatibility Groups from USDA Marketing Research Report 1070 (Lipton & Harvey, 1977). Selected federal regulation entry points: [7 CFR Part 46 \(PACA\)](#); [49 CFR Part 370 \(freight claims\)](#).

Full series

01 The Reefer Is Not a Precooler

02 Colder Is Not Safer

03 Ethylene: The Invisible Load Killer

04 USDA Groups 1–8: The Mixed-Load Playbook

05 Airflow, Load Patterns & Multi-Temp Zones

06 Commodity Setpoint Desk Guide

07 Protein, Dairy & Eggs on the Same Trailer

08 CA, MAP & When Gas Matters

09 From Temperature Log to Claim

10 Seasonal Produce Desk

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