AN EARLY WARNING SYSTEM

TankTerminalTraining *developed an algorithm to test functionality and performance of storage terminals. Please read the outcome of competency risk tests which were performed with the cooperation of 68 loading masters in 5 terminals. This demonstrates that personal competency levels are crucial to the safe operation of our industries. By* ***Arend van Campen, PhD***

To compare operational excellence and HSEQ performance in a marine oil storage terminal operating at 70 percent vs. 85 percent of required information under Van Campen's Law, we need to synthesize a multi-domain analysis — integrating information dynamics, cybernetics, metaphysics, biophysics, and thermodynamics.

VAN CAMPEN'S LAW REFRESHER

Entropy (disorder/dysfunction):

- ¬p(m − (i ≡ e)) > r → ΔS > 0
  → False perception with misaligned info-energy → reality constraints exceeded → rising disorder
- (m − i) > r → ΔS > 0
  → Matter/structure unsupported by info exceeds capacity → system entropy

Negentropy (order/functionality):

- √p(m + (i ≡ e)) ≤ r → J > 0
  → Correct perception + aligned info-energy within constraints → emergence of order
- (m + i) ≤ r → J > 0
  → Structural matter supported by sufficient info stays within operational reality → negentropy

COMPARISON: 70% VS 85% INFORMATION SUFFICIENCY

Metric	Terminal @ 70% Info	Terminal @ 85% Info
Perception (P)	Partial, higher risk of ¬p (false or outdated input)	Closer to √p (accurate, timely, aligned with reality)
Info-Energy Integration (i ≡ e)	Poor integration → energy not optimized	Stronger coupling → info directs energy use efficiently
Reality Constraint (r)	Frequently exceeded ((m−i) > r) → entropy rises	More consistently respected ((m+i) ≤ r) → stability and resilience
Entropy (ΔS)	High: frequent dysfunction, accidents, delays	Low: anticipatory response, process optimization
Negentropy (J)	Low: poor adaptive capacity	High: resilience, functionality, adaptability
System State	Reactive, brittle	Proactive, adaptive

THERMODYNAMIC TESTING (1ST & 2ND LAWS)

1st Law (Energy Conservation)

70 percent Terminal:

- Wastes energy on rework, failures, inefficient routing of tankers, spill containment.
- Poor info quality leads to inefficient energy-to-outcome conversion.

85 percent Terminal:

- Energy better directed through predictive maintenance, real-time feedback, and data-driven logistics.
- System obeys conservation while minimizing loss.

2nd Law (Entropy)

70 percent Terminal:

- Increasing entropy: errors, slow responses, safety lapses.
- System may require external corrections (regulators, emergency responders).

85 percent Terminal:

- Internal feedback prevents entropy buildup.
- Information enables localized negentropy through control loops and self-organization.

CYBERNETIC FEEDBACK (ASHBY'S LAW)

70 percent Terminal:

- Fails Ashby's Law: internal variety < environmental variety → system overwhelmed
- Feedback is slow, filtered, and often non-actionable

85 percent Terminal:

- Feedback aligns with variety of operational context
- Adaptive capacity enables self-regulation and resilience

BIOPHYSICAL VIEW

System as a Semi-Organism

- At 70 percent: Behaves like a diseased cell — lacks signaling clarity → metabolic (operational) disorder
- At 85 percent: Closer to a healthy, homeostatic organism — info flows guide energy use → metabolic coherence

METAPHYSICAL INSIGHT:

System as a Semi-Organism

- 70 percent info: Disconnected from reality's unfolding complexity; functioning on illusion or outdated paradigms → leads to disintegration.
- 85 percent info: System more attuned to ontological reality — allows the terminal to co-evolve with its environment.

EXTERNALITIES OVERVIEW

Category	Terminal @ 70% Info	Terminal @ 85% Info
Negative Externalities	• Increased spills/leaks • Delayed emergency response • Higher insurance/ environmental costs • Worker stress due to unpredictability • Regulatory penalties	• Potential over-reliance on digital systems • Upfront cost of information infrastructure
Positive Externalities	• Few, mostly from regulatory safety net	• Cleaner environment • Safer working conditions • Higher stakeholder trust • Community integration • Cross-learning with other terminals • Lower carbon/energy footprint

HOLISTIC SYNTHESIS

Dimension	Terminal @ 70% Info	Terminal @ 85% Info
Information Dynamics	Under-informed → disorder grows	Sufficiently informed → system coherence
Cybernetics	Weak feedback; fails variety match	Effective real-time regulation
Biophysics	High entropy → instability	Functional, energetic efficiency
Thermodynamics	Poor energy conversion; entropy rises	Efficient use; entropy managed
Metaphysics	Detached from system-environment flow	In tune with reality's complexityy
HSEQ Performance	Lagging, brittle	Robust, anticipatory
Operational Excellence	Compliance-focused; high energy cost	Excellence via adaptivity; low waste

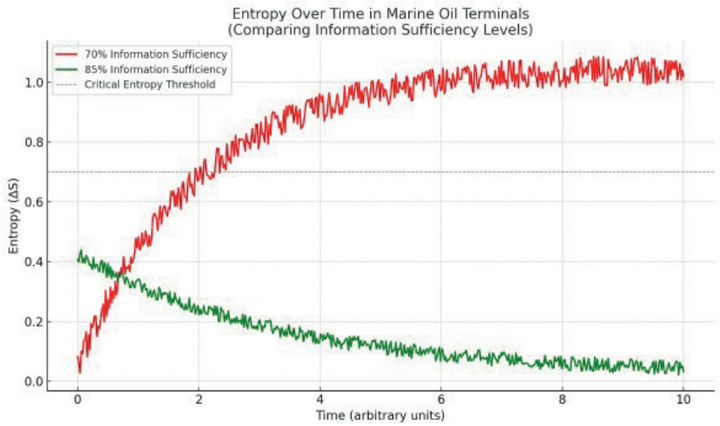
FINAL THOUGHT

A marine oil terminal with 85 percent of required information behaves more like a living, responsive organism — resilient, efficient, and aligned with its environment. At 70 percent, the system risks collapse under entropy, dependent on top-down corrections rather than internal harmony.

HERE'S THE ENTROPY CURVE COMPARING TWO MARINE OIL TERMINALS:

- **Red (70 percent Info):** Entropy increases rapidly, surpassing the critical threshold, indicating a buildup of disorder due to poor information
- **Green (85 percent Info):** Entropy is more controlled and decays over time, showing better system regulation, feedback, and adaptive capacity.

This visual highlights how small improvements in information sufficiency can yield significant gains in stability, efficiency, and risk management.



HERE'S THE NEGENTROPY (J) CURVE, SHOWING HOW SYSTEMIC ORDER EVOLVES OVER TIME:

- **Blue (85 percent Info):** Rapid rise in negentropy, reflecting a system gaining functional order and resilience.
- **Orange (70 percent Info):** Sluggish and inconsistent increase, indicating weak systemic adaptation and potential for chronic dysfunction.

This confirms:
Higher information sufficiency → greater negentropy → better HSEQ and operational performance.