REPUBLIC POLYTECHNIC

E355 : Cold Chain Management

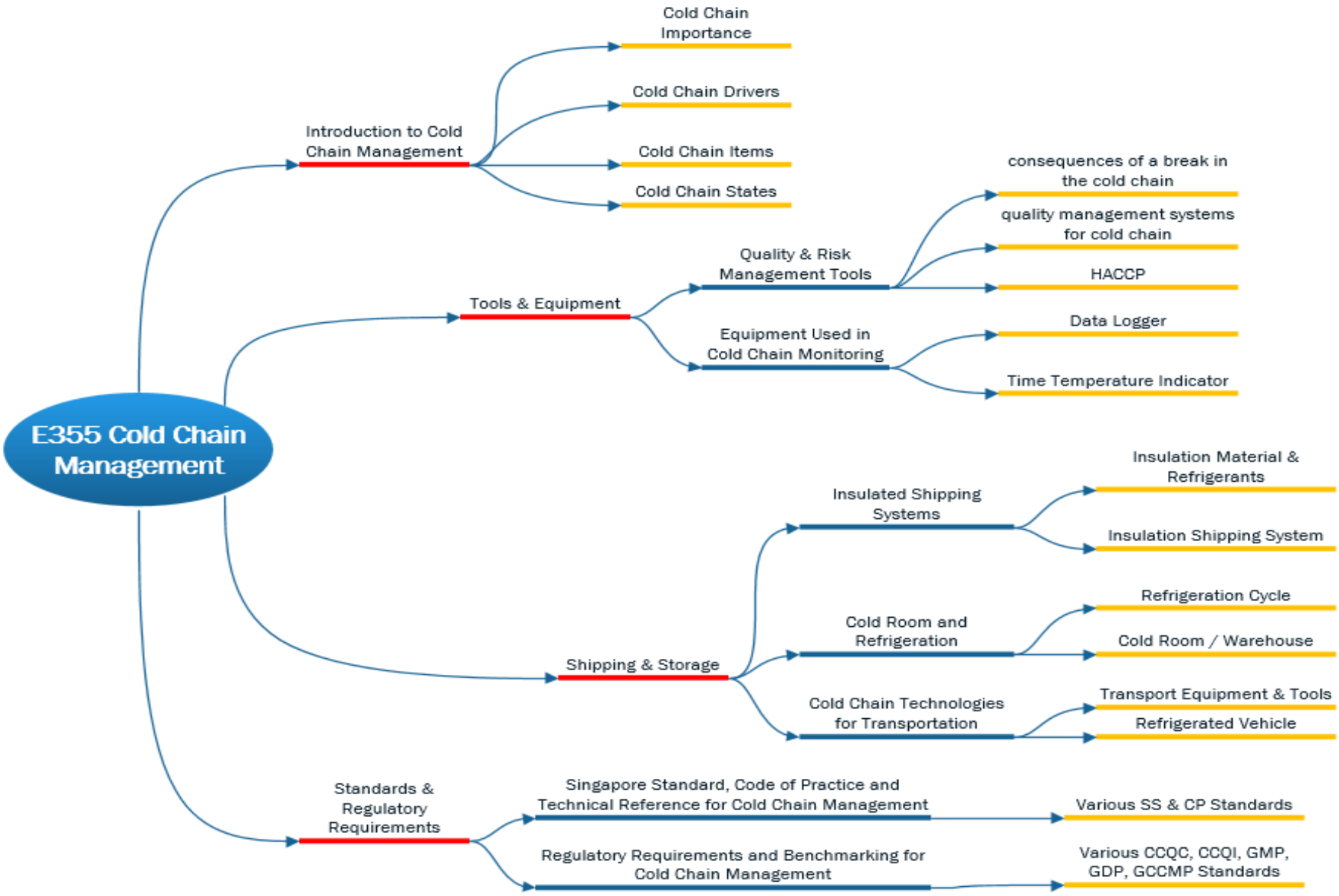
Problem 02

Measure it

- Describe the Typical Components In a Data Logger
- Explain the Importance of Calibration of Data Logger
- Identify the Types of Data Loggers/Temperature Sensors
- Explain the Criteria For Selection Of Data Loggers

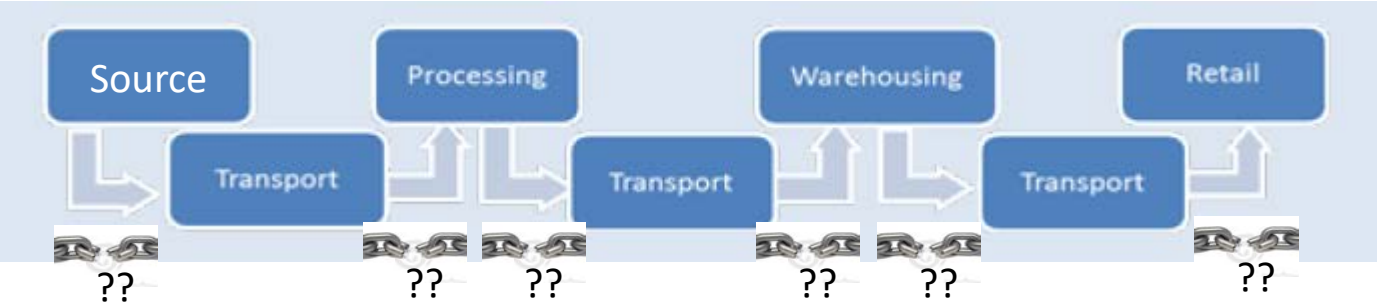
SCHOOL OF ENGINEERING

E355 Cold Chain Management - Topic Tree



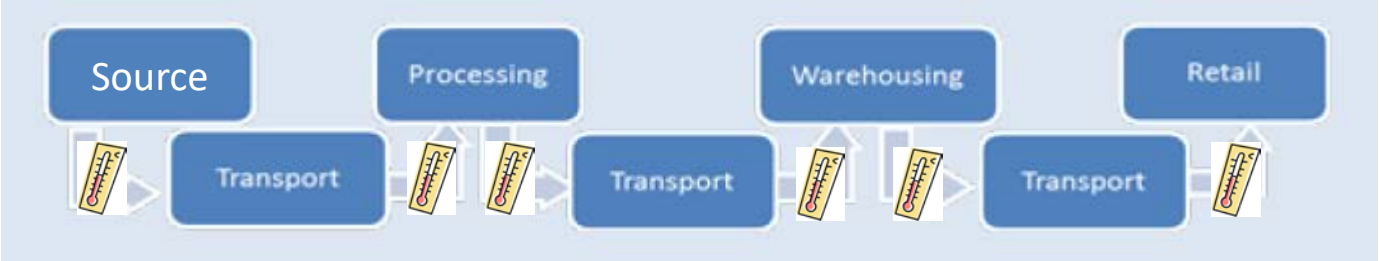
Temperature monitoring in Cold Chain System

Cold Chain System



- How to ascertain any break in cold chain system?
- Break in cold chain system caused by temperature excursion

Cold Chain System



- Temperature monitoring along the cold chain system → Quality assurance of cold chain system

Temperature Monitoring/Tracking Devices Used in Cold Chain System

Types of Temperature Sensors

- The choice of which type of sensor will depend on the requirements for accuracy, speed of response, range of temperatures, robustness and cost
- There are **3 main types of temperature sensors**:

1. Thermocouple

- Based on the fact that a junction between 2 metals generates a voltage that is a function of temperature, discovered by Thomas Seebeck, thus this effect is called **'Seebeck effect'**
- Not for precision and prone to noise, but has a wide temperature range and is relatively low-cost and versatile
- Made of thin wires to minimize thermal shunting and increase response time
- Type 'K' (chromel/ alumel) is the most general purpose kind, ranging from -200 to +1300 °C

Types of Temperature Sensors

2. Resistance Temperature Detector (RTD)

- Most stable and accurate, although expensive and fragile
- Electrical resistance of any metal varies according to its temperature
- Most common type of RTD is the Platinum Resistance thermometer (PRT), e.g. PT100, which is so-called because it has a resistance of 100 ohms at 0 °C

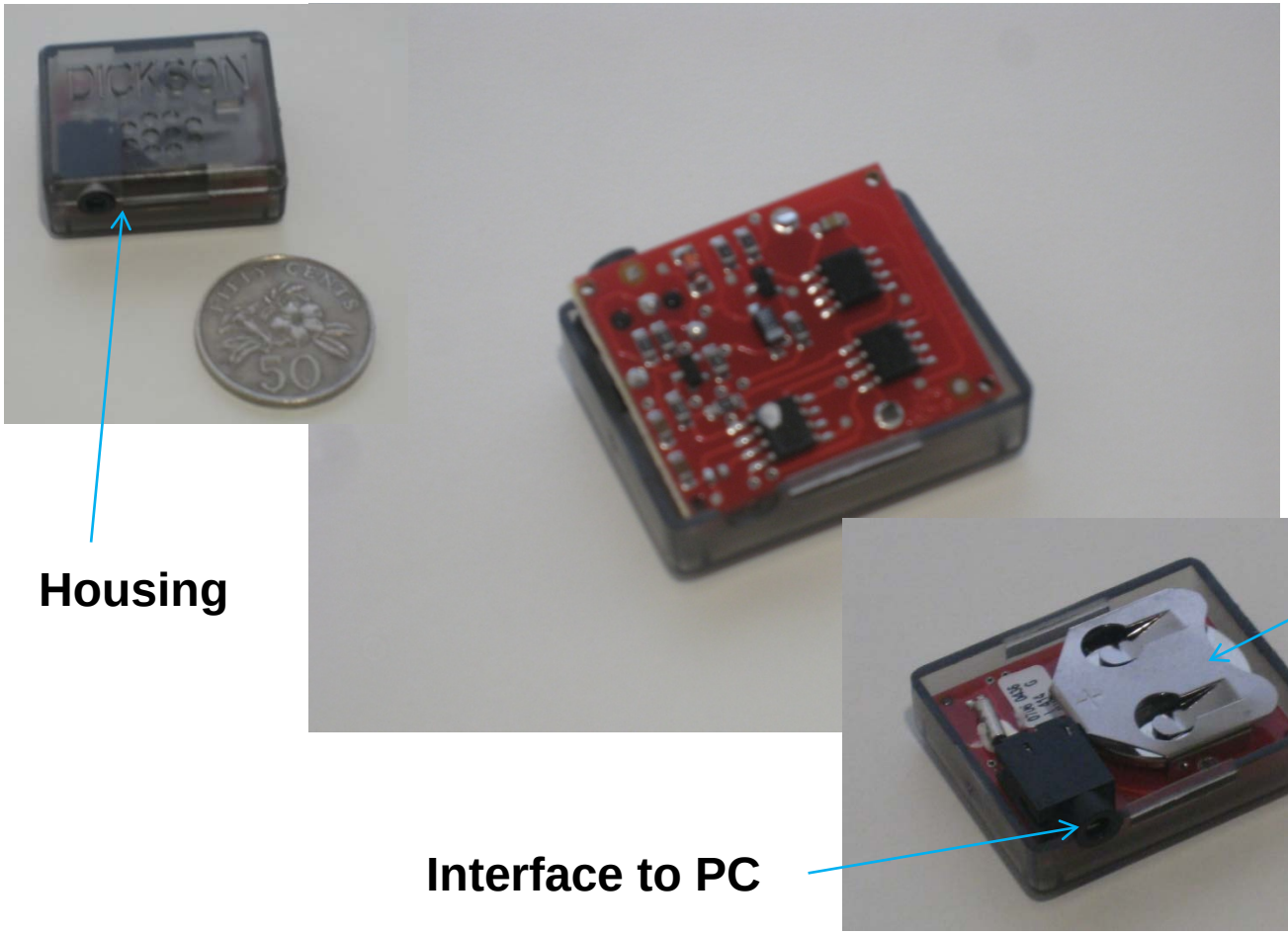
3. Thermistor

- Also exploit the fact that a material's resistance changes with temperature
- High sensitivity and is ideal for detecting small changes in temperature when it is the change and not the absolute value that is important

Comparison Of Temperature Sensors

	Thermocouple	RTD – e.g. PT100	Thermistor
Operating Range	-200 °C to 2000 °C	-250 to 850 °C	-100 to 300 °C
Accuracy	Low 1 °C common	Very High 0.03 °C common	High 0.1°C common
Linearity	Medium	High	Low
Thermal Response	Fast	Slow	Medium
Cost	Low	High	Low to moderate
Noise Problems	High	Medium	Low
Long term stability	Low	High	Medium

Typical Components in a Temperature Data Logger



Calibration and Periodic Verification

- During manufacture, each sensor is checked to ensure that it meets specification and achieves an accuracy within tolerances set by each manufacturer and in accordance with European Standard for temperature recording equipment, EN12830 http://www.seventelematics.co.uk/regulations-european-spec.html

- Once a temperature monitoring system is installed, periodic checks need to be carried out to ensure that the equipment is functioning correctly and meets the same specification as when it was purchased.

- The maximum period recommended is one year for a manufacturer’s check or after a long period of non-use or operating incident.

Calibration And Periodic Verification

Sample Certification Of Validation

International Certificate of Validation

SENSITECH COLD CHAIN VISIBILITY

Ship To Address

Sensitech Asia Pte. Ltd.
Attn: Peter Low
6 Ubi Road 1 #06-13
Wintech Centre, Singapore 408726
Singapore

Bill To Address

Sensitech Asia Pte Ltd.
Attn: Peter Low
6 Ubi Road 1 #06-13
Wintech Centre 408726
Singapore

Order: 293504 - 0
Ship Date: Mar 28, 2008

C5041-20

Line - Box 1 - 2

Line - Box 1 - 2

Unit S/N	Model Number	Description	Validation Date*
3401827481	C5041-20	TT4 2K AMB MU	3/28/2008
3401827497	C5041-20	TT4 2K AMB MU	3/28/2008
3401827506	C5041-20	TT4 2K AMB MU	3/28/2008
3401827512	C5041-20	TT4 2K AMB MU	3/28/2008
3401827525	C5041-20	TT4 2K AMB MU	3/28/2008
3401827531	C5041-20	TT4 2K AMB MU	3/28/2008
3401827563	C5041-20	TT4 2K AMB MU	3/28/2008
3452708001	C5041-20	TT4 2K AMB MU	3/28/2008
3452708003	C5041-20	TT4 2K AMB MU	3/28/2008
3452708055	C5041-20	TT4 2K AMB MU	3/28/2008
3452708058	C5041-20	TT4 2K AMB MU	3/28/2008
3452708061	C5041-20	TT4 2K AMB MU	3/28/2008
3452708064	C5041-20	TT4 2K AMB MU	3/28/2008
3452708065	C5041-20	TT4 2K AMB MU	3/28/2008
3452708069	C5041-20	TT4 2K AMB MU	3/28/2008
3452708078	C5041-20	TT4 2K AMB MU	3/28/2008
3452708080	C5041-20	TT4 2K AMB MU	3/28/2008
3452708087 ✓	C5041-20	TT4 2K AMB MU	3/28/2008
3452708095 ✓	C5041-20	TT4 2K AMB MU	3/28/2008
3452708100	C5041-20	TT4 2K AMB MU	3/28/2008

Total Units: 20

Certified True Copy

Job # 801308 2-293504-02

T83001080 / Rev. F/ 11/02/2007

Sensitech Inc., 800 Cummings Center, Suite 258X, Beverly, MA 01915 USA Tel (978) 927-7033 FAX (978) 921-2112

International Certificate of Validation

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6 Ubi Road 1 #06-13
Wintech Centre, Singapore 408726
Singapore

Bill To Address

Sensitech Asia Pte Ltd.
Attn: Peter Low
6 Ubi Road 1 #06-13
Wintech Centre 408726
Singapore

Order: 293504 - 0
Ship Date: Mar 28, 2008

Sensitech Inc. certifies that the item(s) identified previously have been thoroughly tested per Sensitech Quality Assurance procedures and are validated for one year from the date of sale. They have met performance accuracy specifications* over the stated range. Reference instrumentation used to perform validations is certified traceable in accordance with the National Institute of Standards and Technology (NIST). Validation equipment certifications are on file at Sensitech Beverly Massachusetts, USA.

** For complete accuracy specifications of TempTale monitors, please refer to the published Technical Specifications.*

Reference Instrumentation

Temperature: Ertco-Hart Thermometer, Model EH850C / 1502A, Serial Numbers; A01978, A1B608, A14436, A29918, A3A343, A3A347, A39317, A53912, A53913, A71541, A75693, A75696, A75697, A77738, 76924, 84290, 93656, 95719
Ertco-Hart PRT, Model 5613/5614, Serial Numbers; 528676, 528707, 562963, 649393, 657206, 657208, 74 03, 743967, 751701,773643, 775358, 778117, 778333, 778470, 780363, 784032, 790899, 792016

Accuracy: ±0.05° Celsius over a range of -200° to +200° Celsius.

Humidity: Edgetech Dew Point Hygrometer, Model DewPrime II, Serial Numbers 2312x & 1H906DCR
Accuracy: ±0.5% over a range of 10% to 95% RH.

**** It is recommended that the item(s) listed previously be replaced one year from date of sale.**

Authorized By: Date: *March 28, 2008*

Job Title: *Shipper*

Date of Sale: 15/04/2008

If Applicable:

Customer Commodity Number: _____

Lot Number: _____

****This certificate information, for the order specified, applies to the items identified on the preceding pages****

Certified True Copy

Job # 801308 2-293504-02

T83001080 / Rev. F/ 11/02/2007

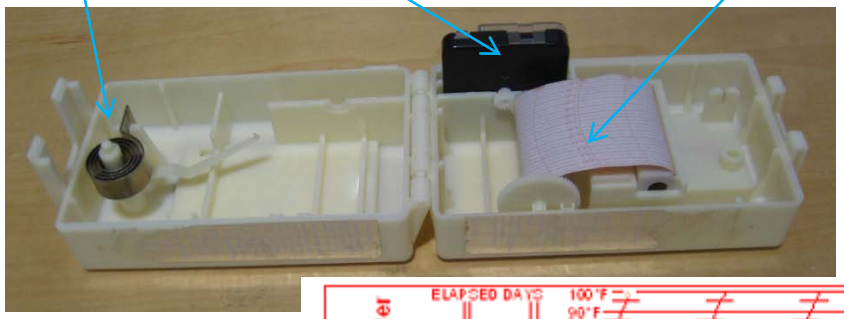
Sensitech Inc., 800 Cummings Center, Suite 258X, Beverly, MA 01915 USA Tel (978) 927-7033 FAX (978) 921-2112

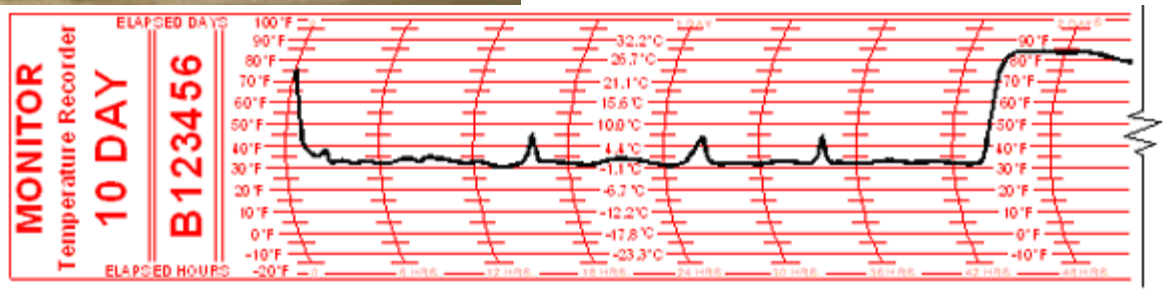
Chart Recorder / Strip Chart

- Most traditional method of recording temperature history
- Charts can be circular or mounted onto a roll to provide a rectangular chart
- Accuracy varies with sensor type

Circular Chart

Sensor **Battery** **Strip Chart**





Mobile Data Logging Systems

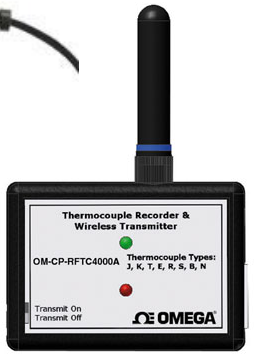
- With miniaturization of circuitry, data loggers have become smaller and more compact, some even smaller than matchboxes
- Small enough to travel with food cartons to monitor temperature during transportation
- Can be of single or multiple use, with or without display
- Usually programmable through software interfaced to PC
- Temperature profile can be downloaded for analysis

Single-use disposable temperature logger

Multiple use temperature logger

Fixed Data Loggers

- Commonly used in cold room / warehouses
- Historical data can be downloaded onto computers for analysis and charting
- Usually installed with alarms (visual / audio) if temperature range is violated
- Typically incorporated with relative humidity sensors



Infrared Non-Contact Thermometers

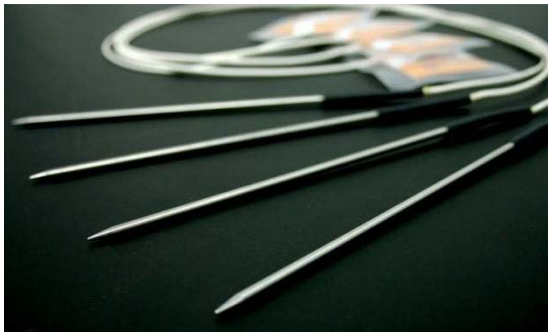
- **Infrared (IR) thermometers** measure temperature using blackbody radiation (generally infrared) emitted from objects. It is not used for data logging, but for instant scanning.
- IR thermometers response quickly but they only measure the surface temperature of object
- Temperature measurement can be greatly affected by environmental lighting or packaging material of object

RFID Smart Card Logger

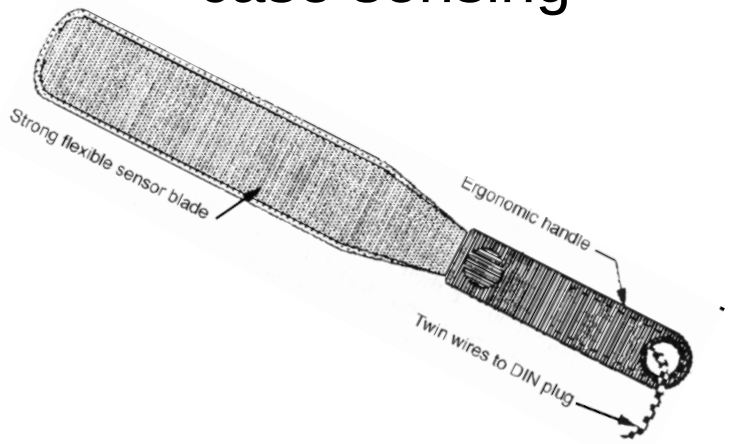
- Semi-passive RFID tags, battery powered
- RFID enabled, functions as a supply chain tracking tool, with capability of logging temperature
- Light weight and flexible

Temperature Sensors With Probe

Probes are commonly used to sense core temperature of food (sharpened tip)



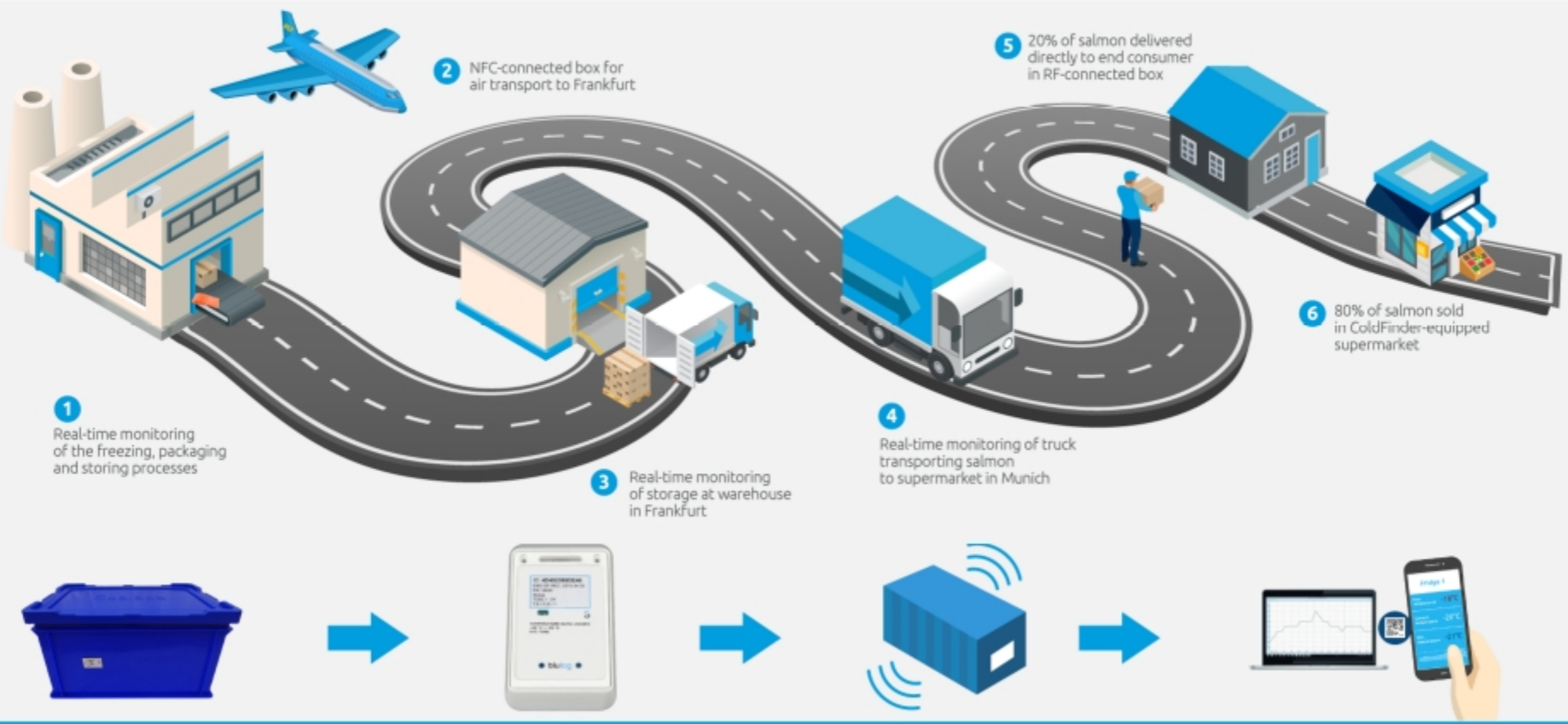
Probe used for between case sensing



Blulog NFC dataloggers

Blulog secures the cold chain with its wireless, credit-card size and affordable devices

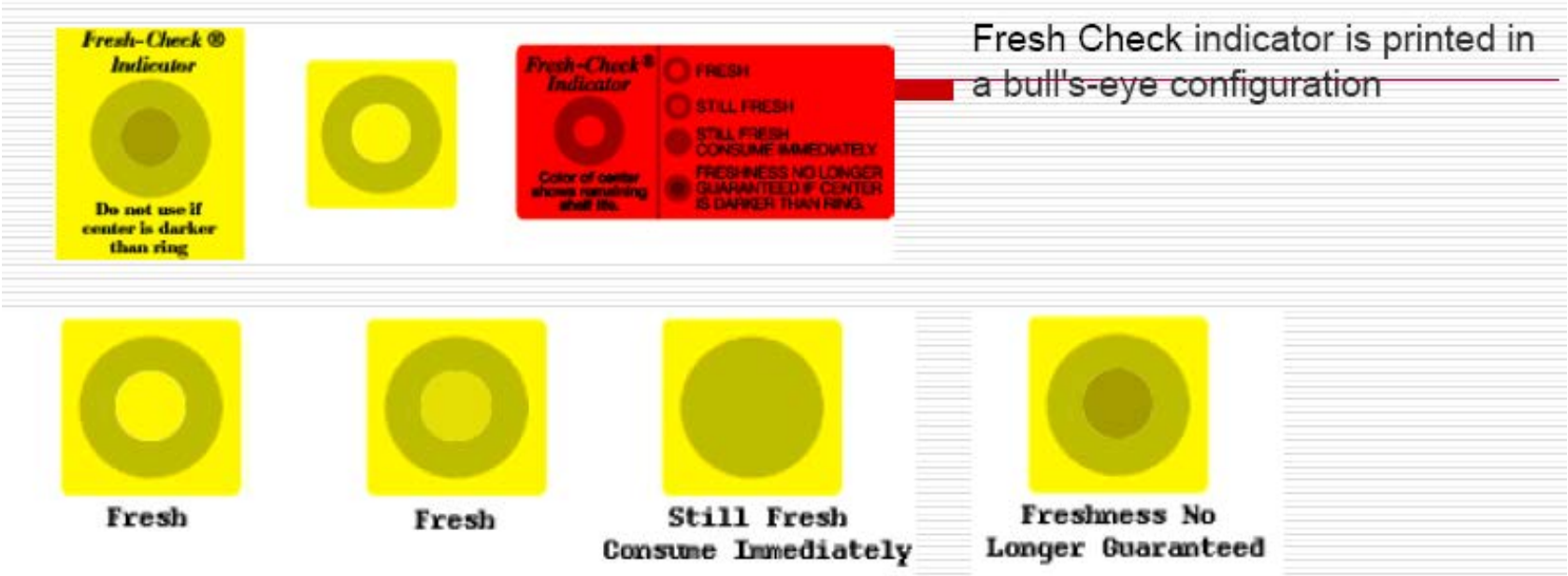
Example of supply chain for salmon: from Alaska to the final consumer in Munich



blulog

Time Temperature Indicators (TTI)

- Fresh Check indicators are color-changing, self-adhesive labels which respond to cumulative exposure to temperature. The indicator center irreversibly darkens, faster at higher temperatures



Time Temperature Indicators (TTI)

Freeze tags – shows on display if there has been an exposure of below 0°C for over 10 minutes

Exposed to temperature above 0 deg C after 30min

Exposed to temperature above 0 deg C after 4hrs

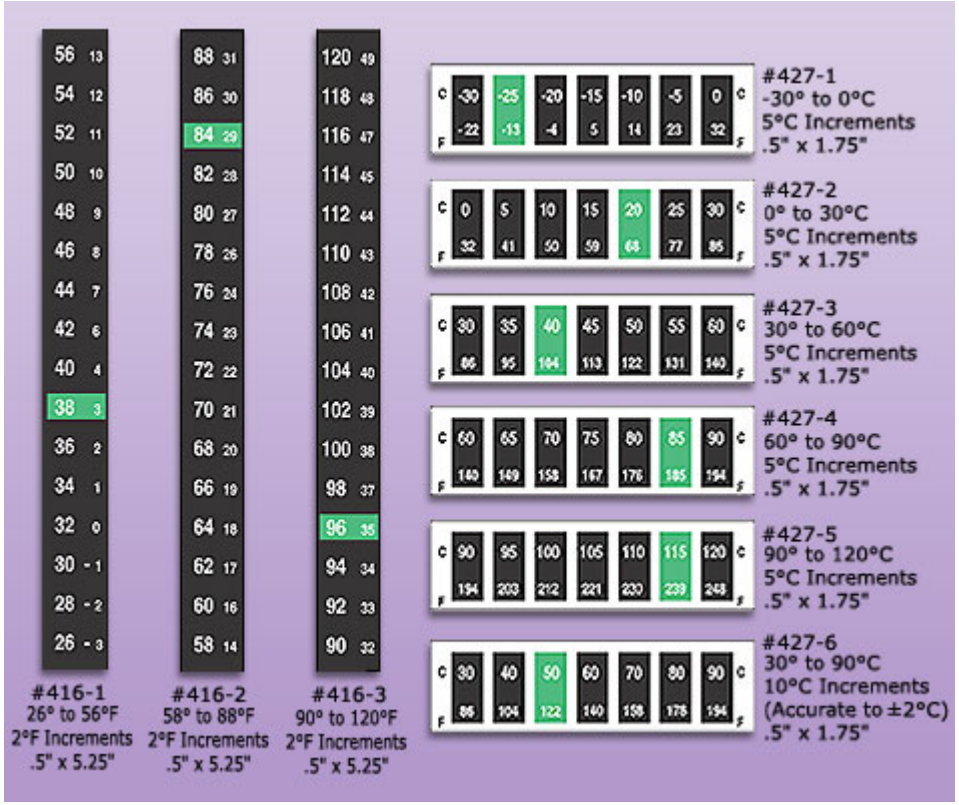
Exposed to temperature above 0 deg C after 12hrs

WarmMark™ indicators monitor whether a product has been exposed to temperatures above a pre-determined threshold as a red dye is released to indicate the duration

Other Variation Of Temperature Sensors

Liquid Crystal Thermometer

Each liquid crystal is formulated for a specific temperature response, window changes colour for continuous visual monitoring of surface temperatures from -30°C TO 120°C



Selecting a Temperature Monitor System

Factors to consider:

- Single use or multiple use
- Display or without display
- Strip Chart / Digital / RFID
- Fixed or mobile
- Quality assured validation
- Measurement of surface, air or core temperature?
- Measure relative humidity?
- Interface with PC needed?
- Cost
- Alarm capabilities
- Temperature range
- Response time
- Battery life
- Recording interval
- Recording duration
- Recording accuracy
- Memory size

Comparison of Data Loggers in SCIL (Example)

Data Logger	Additional Features	Temperature range	Temperature accuracy	Temperature resolution	LCD Display	Start/ stop button	Alarm	Data sampling interval	Special Requirements?
Sensitech Temptale 4	Probeless, Flexible probe and needle probe, dry ice logger	-30°C to +70°C (-80°C to +30°C for dry ice logger)	±0.55°C to ±1.1°C	0.1°C	Yes	Yes	Yes	10s to 120min	Software + reader
Thermassure RFID tags	Flexible, RFID capabilities	-45°C to +110°C	NA	0.1°C	No	Yes	Yes	1min to 255min	Software + reader
Libero PDF logger	Built in USB drive and PDF report generator, making raw data tamper-proof	-35°C to +70°C	±0.2°C	0.1°C	Yes	Yes	Yes	1min to 60min	Software for analysis
Fluke 561 IR Thermometer	Surface temperature quick response. Comes with thermocouple.	-40°C to +550°C	±1°C	0.1°C	Yes	Yes	No	NA	NA

Today's Problem

- The following devices could be used at each stage of the cold chain system:
  - Fixed data logger to measure ambient temperature of cold room warehouse
  - Mobile data logger (e.g. Libero PDF Data Logger) to be packed with the products all the way from warehouse to customers
  - WarmMark™ indicators to be attached to the boxes to alert handlers if here is any temperature excursion during the journey of delivery
  - Mobile data logger with alarm (e.g. Temptale 4) inside refrigerated truck to monitor the truck temperature
  - For fast scanning of temperature at receiving area, can use Caen RFID data loggers
  - For continuous monitoring of the products, can use Blulog Real-time monitoring solution

Learning Objectives

- Describe the Typical Components In a Data Logger
- Explain the Importance of Calibration of Data Logger
- Identify the Types Of Data Loggers/Temperature Sensors
- Explain the Criteria For Selection Of Data Loggers