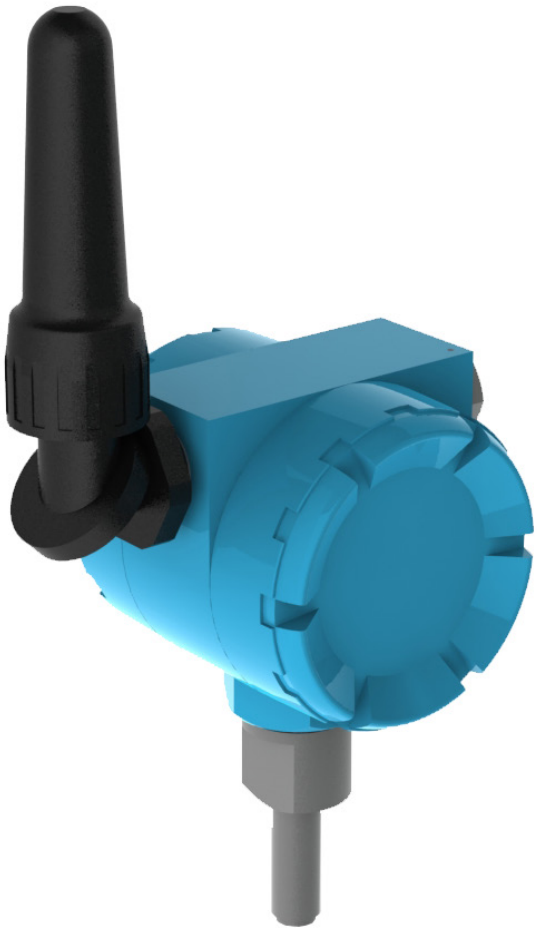
Armstrong®

Intelligent System Solutions®
STEAM • AIR • HOT WATER

Design Specification

AIM® Functional Design Specification

This document is designed to describe the functionality and specifications of the Armstrong Intelligent Monitoring (AIM) System. The purpose of this FDS is to highlight and describe in detail the functionality and operation of the AIM System.



AIM®
ARMSTRONG INTELLIGENT MONITORING

Armstrong®

Armstrong Intelligent Monitoring (AIM®) System

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Section 1: AIM® System

1.0 Overview & Fundamentals

The AIM® System is designed to monitor and evaluate the condition of steam and process equipment. It is comprised of a wireless monitor, wireless gateway (receiver), and Monitoring and Analytics Software (user interface system). The wireless monitor is installed in the field and gathers performance information. The data is transmitted to the gateway wirelessly using the WirelessHART communication protocol. The gateway contains a database that can be polled by the AIM® Monitoring and Analytics Software. The Software collects this data from multiple gateways (if required) and offers an intuitive interface that allows the user further data manipulation capabilities.

Section 2: AIM® Field Monitoring Devices (Transmitters)

2.0 AIM Field Device Fundamentals

Armstrong Intelligent Monitoring Devices comprise three unique device types:

- Steam Trap Monitoring Device – Model ST5700
- Acoustic Monitoring Device – Model AD5000
- Temperature Monitoring Device – Model TD5100

2.1 ST5700 Device Fundamentals

Model ST5700 is a wireless monitoring technology that efficiently monitors and evaluates steam trap operation. The AIM® ST5700 detects potential issues by utilizing piezoelectric sensor and thermistor sensor technology. This technology allows the AIM® ST5700 to identify steam trap failures. This information is then communicated wirelessly to the Gateway.

2.1.1 Data collected by the ST5700 Monitor

The ST5700 performs steam trap analysis on a set time basis (default 1 hour). The analysis consists of the following steps:

- Temperature measurement and comparison
  - Sample temperature (Secondary Variable or SV)
  - Compare sampled temperature reading against the Temperature Setting (Tertiary Variable or TV)
  - **If** SV ≤ TV, **Then** Primary Variable (PV) equals 2, Steam Trap is Cold
  - **If** SV > TV, **Then** perform acoustic evaluation
- Acoustic Evaluation
  - Sample Acoustic signature from Steam Trap using Piezoelectric sensor
  - Evaluate Acoustic signature using Armstrong technology
  - **If** acoustic signature = OK, **Then** Primary Variable (PV) is equal to 1, Steam Trap OK, device enters sleep mode until next scheduled measurement
  - **If** acoustic signature = Blow Thru, **Then** device enters 30 minute test algorithm
    - **If** 30 minute test algorithm determines trap is OK, **Then** Primary Variable (PV) is equal to 1 (OK)
    - **If** 30 minute test algorithm determines trap is Blow Thru, **Then** Primary Variable (PV) is equal to 3 (Steam Trap is Blowing Thru live steam)

2.1.2 Data Transmitted by the ST5700 Monitor

Information	Device ID	HART Tag	Primary Variable (PV)	Secondary Variable (SV)	Tertiary Variable (TV)	Quaternary Variable (QV)
Steam Trap— Model ST5700	✓	✓	Trap Condition • 1 – OK = no alarm; steam trap is functioning properly. • 2 – CD = alarm; steam trap plugged/locked or steam supply valve off. • 3 – BT = alarm; steam trap failed to open, experiencing steam loss.	Current temperature reading (°F or °C)	Temperature Setting*	Estimated Battery Life (Days)

Table 3: ST5700 Transmitted Data

2.2 AIM® AD5000 Device Fundamentals

Model AD5000 is a wireless monitoring technology that efficiently monitors and evaluates safety relief valves' and other mechanical valves' operation. The AIM® AD5000 detects potential issues by utilizing piezoelectric sensor and thermistor sensor technology. This technology allows the AIM® AD5000 to identify valve lifts and leaks. This information is then communicated wirelessly to the Gateway.

2.2.1 Data collected by the AD5000 Monitor

The AD5000 performs analysis on a set time basis. The analysis consists of the following steps:

- Acoustic Evaluation and comparison
  - Sample Acoustic signature from valve using Piezoelectric sensor (Primary Variable or PV)
    - Acoustic signature is measured on a scale from 0 to 255.
      - 0 = no acoustic signature measured
      - 255 = max acoustic signature measured (circuit saturation)
- Temperature measurement
  - Sample temperature (Secondary Variable or SV)

2.2.2 Data Transmitted by the AD5000 Monitor

Information	Device ID	HART Tag	Primary Variable (PV)	Secondary Variable (SV)	Tertiary Variable (TV)	Quaternary Variable (QV)
Acoustic— Model AD5000	✓	✓	Counts (0-255)	Current temperature reading (ºF or ºC)	Alarm Setting (default 0)	Estimated Battery Life (Days)

Table 4: AD5000 Transmitted Data

2.3 AIM® TD5100 Device Fundamentals

Model TD5100 is a wireless monitoring technology that efficiently monitors and evaluates surface and area temperatures. The AIM® TD5100 detects potential issues by utilizing thermistor sensor technology. This technology allows the AIM® TD5100 to identify surface or area temperatures for further evaluation and analysis. This information is then communicated wirelessly to the Gateway.

2.3.1 Data collected by the TD5100 Monitor

The TD5100 performs analysis on a set time basis. The analysis consists of the following steps:

- Temperature measurement
  - Sample surface or area temperature (Primary Variable or PV)

2.3.2. Data Transmitted by the TD5100 Monitor

Information	Device ID	HART Tag	Primary Variable (PV)	Secondary Variable (SV)	Tertiary Variable (TV)	Quaternary Variable (QV)
Temperature— Model TD5100	✓	✓	Temperature (ºF or ºC)	Status Bit • 1 – Temp. above setting • 2 – Temp. below setting	Temperature Setting	Estimated Battery Life (Days)

Table 5: TD5100 Transmitted Data

2.4 AIM® Device Mounting Hardware

The AIM® Devices utilize a rigid saddle clamp style mounting bracket developed by Armstrong called a Waveguide and Tempguide. The mounting hardware consists of an upper and lower saddle and fasteners. See table 6 for details and size options.

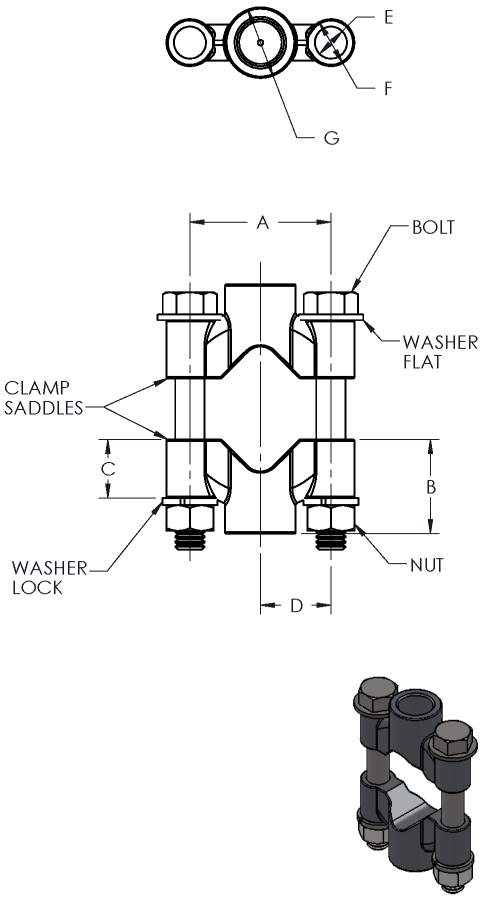


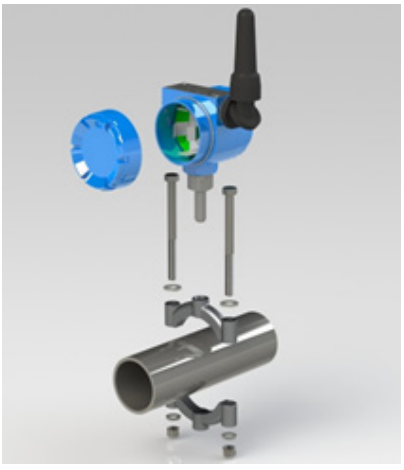
Table 6: Waveguide Table (For pipe sizes above 3" consult factory for specifications)

Waveguide Dimensions 1/2" - 1-1/4" (15-32)				
Waveguide Pipe Size	1/2 (15)	3/4 (20)	1 (25)	1-1/4 (32)
A	1.5 (38.1)	1.5 (38.1)	2.12 (53.8)	2.12 (53.8)
B	1 (25.4)	1 (25.4)	1.2 (30.5)	1.2 (30.5)
C	0.62 (15.7)	0.62 (15.7)	0.78 (19.8)	0.78 (19.8)
D	0.75 (19.1)	0.75 (19.1)	1.06 (26.9)	1.06 (26.9)
E	0.34 (8.6)	0.34 (8.6)	0.34 (8.6)	0.34 (8.6)
F	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)
G	0.75 (19.1)	0.75 (19.1)	0.75 (19.1)	0.75 (19.1)
Weight lbs (kg)	0.3 (0.14)	0.3 (0.14)	0.4 (0.2)	0.4 (0.2)
Clamp Saddles	316SS	316SS	316SS	316SS
Bolt*	Hex HD 5/16-18 x 2.5 (64) LG	Hex HD 5/16-18 x 2.5 (64) LG	Hex HD 5/16-18 x 2.5 (64) LG	Hex HD 5/16-18 x 2.5 (64) LG
Washer Flat*	5/16 (7.9)	5/16 (7.9)	5/16 (7.9)	5/16 (7.9)
Washer Lock*	5/16 (7.9)	5/16 (7.9)	5/16 (7.9)	5/16 (7.9)
Nut*	Hex HD 5/16-18	Hex HD 5/16-18	Hex HD 5/16-18	Hex HD 5/16-18

Waveguide Dimensions 1-1/2" - 3" (40-80)				
Waveguide Pipe Size	1-1/2 (40)	2 (50)	2-1/2 (65)	3 (80)
A	2.75 (69.9)	2.75 (69.9)	3.37 (85.6)	3.37 (85.6)
B	1.5 (38.1)	1.5 (38.1)	1.6 (40.6)	1.6 (40.6)
C	1.05 (26.7)	1.05 (26.7)	1 (25.4)	1 (25.4)
D	1.38 (34.9)	1.38 (34.9)	1.69 (42.8)	1.69 (42.8)
E	0.41 (10.4)	0.41 (10.4)	0.41 (10.4)	0.41 (10.4)
F	0.7 (17.8)	0.7 (17.8)	0.7 (17.8)	0.7 (17.8)
G	0.75 (19.1)	0.75 (19.1)	0.75 (19.1)	0.75 (19.1)
Weight lbs (kg)	0.3 (0.14)	0.3 (0.14)	0.4 (0.2)	0.4 (0.2)
Clamp Saddles	316SS	316SS	316SS	316SS
Bolt*	Hex HD 5/16-18 x 2.5 (64) LG	Hex HD 3/8-16 x 4.0 (76) LG	Hex HD 3/8-16 x 4.0 (76) LG	Hex HD 3/8-16 x 4.0 (76) LG
Washer Flat*	5/16 (7.9)	5/16 (7.9)	3/8 (7.9)	3/8 (7.9)
Washer Lock*	5/16 (7.9)	5/16 (7.9)	3/8 (7.9)	3/8 (7.9)
Nut*	Hex HD 5/16-18	Hex HD 3/8-16	Hex HD 3/8-16	Hex HD 3/8-16

* Gr. 5, Zinc Plate .0015 THK, Per ASTM A633

Installation Example



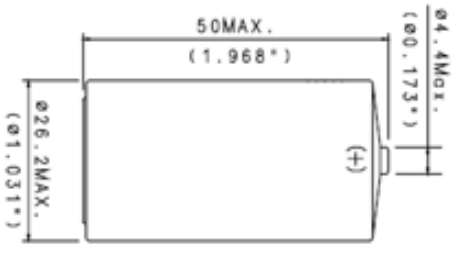
2.5 AIM® Device Battery

The AIM® devices utilize a Model TLH-5920 Lithium Ion battery, see table 7 for technical specifications and dimensions.

TECHNICAL DATA

(Typical values @+ 25ºC for batteries stored for one year or less)

Nominal capacity @ 3 mA, to 2 V	7.5 Ah
Rated voltage	3.6 V
Maximum recommended continuous current	230 mA
Maximum pulse current capability	400 mA
Weight	49.5 g (1.75 oz)
Volume	26 cc
Operating temperature range	-55 ºC to +125 ºC
Li metal content	approx. 2.5 g
U.L. Component Recognition, MH 12193	



2.6 AIM® Device Technical Specifications and Approvals

The AIM® devices are designed to operate in hazardous environments. See Table 9 below:

Output	*Wireless*HART 2.4 GHz
Local Display (if applicable)	Liquid Crystal Display Viewing Area: 1.34" x 0.55" (34 mm x 14 mm)
Temperature Operating Range	With display: -30ºC to 80ºC (-22ºF to 176ºF) Without display: -40ºC to 90ºC (-40ºF to 194ºF)
Max Pipe Temperature	315ºC (600ºF) - Heat sink required
Materials of Construction	Housing – Aluminum Paint – Powder Coat O-ring – Nitrile Stem – 304 SS Antenna – Nylon 6,6 Nampelate – 304 SS
Battery Type	Tadiran Lithium Ion Model – TLH-5920
Weight	2.2 lbs (1 Kg)

Table 8: Technical Specifications

Factory Mutual (FM) Approval	
United States	Intrinsic Safe for Class I/II/III, Division 1, Groups A, B, C, D, E, F, and G Zone Rating: Zone 0, AEx ia IIC Temperature Code: T3 Ambient Temperature Range: T_{amb} -40ºC to 90ºC (-40ºF to 194ºF) For use with TADIRAN model TLH-5920 lithium ion battery only Standards used for Certification: FM3600, FM3610, FM3810, ANSI/ISA 60079-0, ANSI/ISA 60079-11
Canada	Intrinsic Safe for Class I/II/III, Division 1, Groups A, B, C, D, E, F, and G Zone Rating: Zone 0, Ex ia IIC Temperature Code: T3 Ambient Temperature Range: T_{amb} -40ºC to 90ºC (-40ºF to 194ºF) For use with TADIRAN model TLH-5920 lithium ion battery only Standards used for Certification: CSA 1010.1, CSAC22.2No.157, CSAC22.2No.25,CAN/CSAE60079-0, CAN/CSA60079-11
European Certification	ATEX Intrinsic Safety Ex ia IIC T3 Ambient Temperature Range: T_{amb} -40ºC to 90ºC (-40ºF to 194ºF) For use with TADIRAN model TLH-5920 lithium ion battery only Standards used for Certification: EN60079-0,EN60079-11, EN 60079-26
IECEx Certification	Equipment Protection Level: Ga Gas/Vapour: EX ia IIC T3 Ambient Temperature Range: T_{amb} -40ºC to 90ºC (-40ºF to 194ºF) For use with TADIRAN model TLH-5920 lithium ion battery only Standards used for Certification: IEC 60079-0, IEC 60079-11, IEC 60079-26

Table 9: Hazardous Approvals

Section 3: WirelessHART Communication

3.0 Overview & Fundamentals

AIM® utilizes the 3.1. WirelessHART communication protocol. WirelessHART uses IEEE 802.15.4 compatible radios operating in the 2.4GHz Industrial, Scientific, and Medical radio band. The radios employ direct-sequence spread spectrum technology and channel hopping for communication security and reliability, as well as TDMA synchronized, latency-controlled communications between devices on the network. This technology has been proven in field trials and real plant installations across a broad range of process control industries.

Each device in the mesh network can serve as a router for messages from other devices. In other words, a device doesn't have to communicate directly to a gateway, but just forward its message to the next closest device. This extends the range of the network and provides redundant communication routes to increase reliability.

The AIM® wireless gateway determines the redundant routes based on latency, efficiency and reliability. To ensure the redundant routes remain open and unobstructed, messages continuously alternate between the redundant paths. Consequently, like the Internet, if a message is unable to reach its destination by one path, it is automatically re-routed to follow a familiar, redundant path with no loss of data.

The mesh design also makes adding or moving devices easy. As long as a device is within range of others in the network, it can communicate.

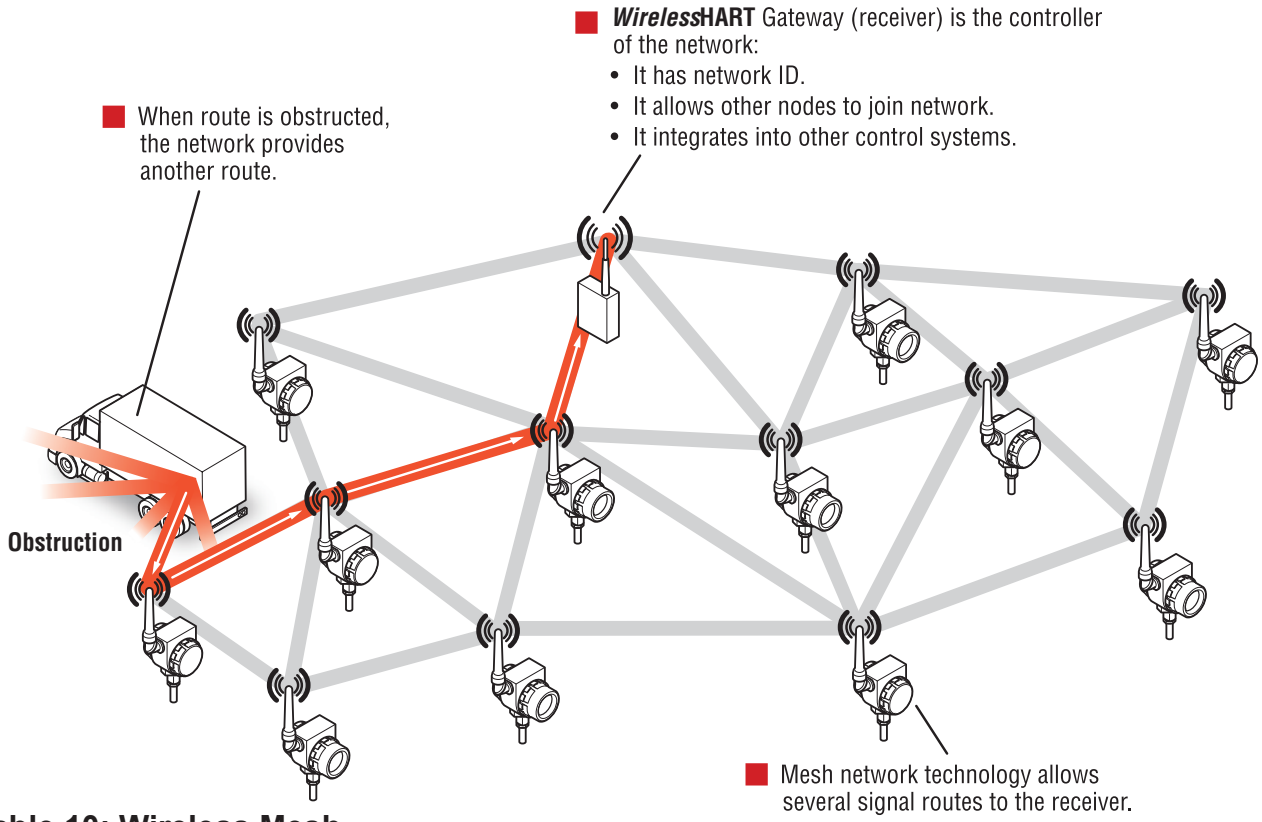


Table 10: Wireless Mesh

3.1 WirelessHART Securities

The WirelessHART technology is designed to enable secure industrial wireless sensor network communications while ensuring ease-of-use is not compromised. Security is built in and cannot be disabled. It is implemented with end-to-end sessions utilizing AES-128 bit encryption. These sessions ensure that messages are enciphered such that only the final destination can decipher and utilize the payload created by a source device.

3.2 WirelessHART Data Protection

Security features associated with privacy aim to prevent eavesdropping by unauthorized devices inside or outside the network. A common network encryption key is shared among all devices on a network to facilitate broadcast activity as needed. Encryption keys can be rotated as dictated by plant security policy to provide an even higher level of protection.

A separate 128 bit join encryption key is used to keep data sent and received during the joining process private. The join key also serves as authentication to the security manager that the device belongs to this network. The join key is treated separately from the other keys to enhance security. Join keys can either be unique to each device, or be common to a given WirelessHART network based on the user security policies.

Data Protection security features associated with Integrity ensures that data sent over the wireless sensor network has not been tampered with or falsified. WirelessHART computes an encrypted message integrity check field that is added to each packet. The receiving device uses this message integrity check field along with the protected data to confirm the contents of the packet have not been altered. The message integrity check field also protects the network routing information as well. This prevents attacks that attempt to change the packet's network/transport layer information.

Data Integrity also involves verifying that the packet has come from the correct source. The network/transport layer message integrity check field, the information used to generate the check field, and the sender/receiver unique session key that codes/decodes the data are tools that can be used to verify the source.

3.3 WirelessHART Network Protection

A wireless sensor network also needs tools to protect it against attacks. Network security depends upon techniques to support Authentication, Authorization, and Attack Detection.

An AIM® gateway and the AIM® devices joining the network must be configured to control which devices are allowed to access the network. The network will only be secure if all the devices in the wireless network maintain security. An AIM® gateway therefore has a secure authentication process which it uses to negotiate with all joining devices to ensure they are legitimate. As with all other network communications, all join negotiation traffic is encrypted end-to-end.

3.4 WirelessHART Co-Existence with other wireless systems

Co-existence is defined as “The ability of one system to perform a task in a given shared environment where other systems have an ability to perform their task and may or may not be using the same set of rules.” Successful co-existence is measured by the reliability of each network to deliver its messages to the desired destination. Therefore, each network must be able to accomplish its objective while not disrupting the ability of another network to complete its objective.

Problems can occur when two or more packets of information are transmitted at the same time and frequency such that they “collide” in the same physical space. If networks aren’t designed to minimize or avoid these occurrences, unreliable communications will result.

There are several techniques that can be used to minimize network interference:

- Channel hopping – changing the frequency channel
- Time Division Multiplexing – varying the time of communications
- Power Modulation – low power transmission
- Direct Sequence Spread Spectrum
- Mesh networking supports large physical space with low power instruments
- Blacklisting and channel assessment

In the data link layer of the WirelessHART protocol, packet acknowledgment with automatic retry assures data is not lost if interference does happen to occur.

3.4.1 Channel Hopping

As specified by IEEE802.15.4, the 2.4 GHZ ISM frequency band is divided into 16 non-overlapping frequency channels. WirelessHART instruments use a pseudo-random channel hopping sequence to reduce the chance of interference with other networks, such as IEEE802.11b/g (Wi-Fi) which operates in the same ISM frequency band.

Pseudo-random channel hopping inherent to WirelessHART instruments ensures that they do not fix on using a channel being used by an IEEE802.11b/g network for any lengthy period of time. Together with the other techniques listed, the probability of interference is minimal either way.

3.4.2 Time Division Multiplexing

A WirelessHART network utilizes Time Division Multiple Access (TDMA) technology to ensure that only one instrument is talking on a channel at any given time. This prevents message collisions within the WirelessHART network. A network is provided with an overall schedule which is divided into 10 msec timeslots. At any time, only one pair of instruments are communicating on the same frequency channel, however, it is possible that more than one pair of instruments can communicate at the same time using different channels. In most cases, only one pair of instruments is communicating in a given timeslot so the WirelessHART network will not monopolize the frequency spectrum that is shared with other wireless networks.

3.4.3 Power Modulation

The IEEE802.15.4 radios were chosen because they are relatively low power instruments suited to wireless process control applications, as well as being readily available at a reasonable cost. The radios are used with 10dB amplifiers to allow communication of up to 200m to the next instrument, which in turn can serve as a router to pass the message along. In cases where the full distance is not required, WirelessHART instruments can transmit at a lower power to reduce the chance of interfering with other networks in the ISM frequency band. The lower transmit power of WirelessHART instruments also means that any chance of interfering with a IEEE802.11b/g Wi-Fi network is small.

3.4.4 Direct Sequence Spread Spectrum

Direct Sequence Spread Spectrum (DSSS) technology provides about 8dB of additional gain utilizing unique coding algorithms. The transmission is spread over the entire frequency of the selected 802.15.4 channel. Devices with the correct decoding information can receive the data while others see the transmissions as white noise and disregard it. This allows multiple overlapping radio signals to be received and understood only by other devices in their own networks.

3.4.5 Mesh Networking

The use of mesh networking technology complements the use of the low power IEEE802.15.4 radios. With mesh networking, instruments do not need to have a direct transmission path to the network Gateway. It is only required that any instrument be able to communicate to any other instrument in the mesh network. Each AIM® ST5700 device is capable of routing the message of other devices along a route that will ensure the message is received at its ultimate Gateway destination. Mesh networks also provide path redundancy and thus achieve better reliability than if each device were required to have a direct line of sight path to the Gateway. The mesh network can adapt to changing communication and other environmental conditions to find a reliable communication path to the Gateway.

3.4.6 Blacklisting and Channel Assessment

In conjunction with channel hopping the WirelessHART network can be configured to avoid specific channels that are highly utilized by other networks and therefore likely to provide interference. However because most networks are not loaded continuously this is rarely required.
To further avoid any conflict with other neighboring networks an AIM® Device listens to the frequency channel prior to transmitting data. If other transmissions are detected the AIM® Device will back off and attempt the communication in another timeslot on a different frequency.

Section 4: AIM® Wireless Gateway

4.0 Overview & Fundamentals

The AIM® wireless gateway connects AIM® WirelessHART self-organizing networks with host systems and data applications. Modbus communications over RS-485 or Ethernet provide universal integration and system interoperability. The OPC functionality from the gateway offers a means to connect to newer systems and applications while providing a richer set of data.

The AIM® wireless gateway provides industry leading security, scalability, and data reliability. Layered security ensures that the network stays protected. Additional devices can be added at any time. There is no need to configure communication paths because the gateway manages the network automatically. This feature also ensures that the AIM® devices have the most reliable path to send data.

4.1 AIM® Wireless Gateway Functions

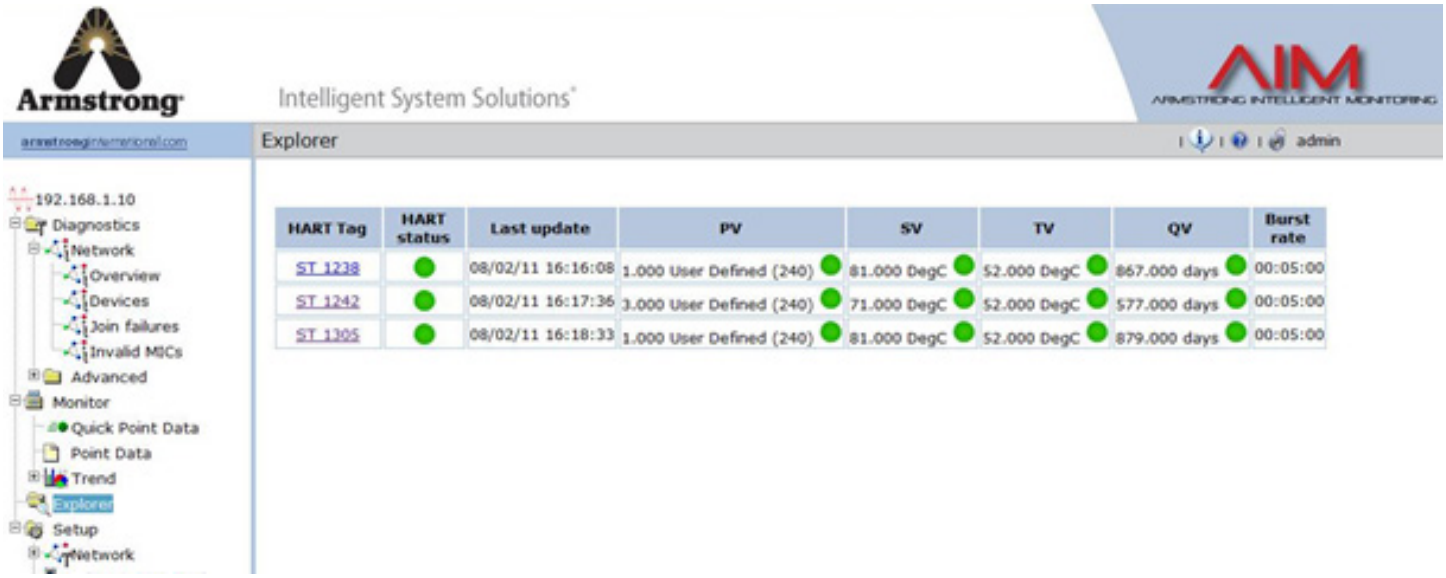
- Builds and maintains the MESH network. It identifies the best paths and manages distribution of slot time access. Slot access depends upon the required process value refresh rate and other access (alarm reporting – configuration changes).
- Provides the connection to the host network.
- Receive transmitted information from AIM® devices (see tables 3, 4, 5)
- Provides a human interface to configure network and device settings
- Hosts data integration tables for control systems software

4.2 AIM® Wireless Gateway Functional Specifications

- **Input Power** - 10.5-30 VDC
- **Current Draw** - Operating Current Draw is based on 3.6 Watts power consumption. Momentary startup Current Draw up to twice operating Current Draw.
- **Radio Frequency Power Output from Antenna**
    - Maximum of 10 mW (10 dBm) EIRP
    - Maximum of 40 mW (16 dBm) EIRP for WL2 High Gain option
- **Environmental**
    - Operating Temperature Range: -40 to 158 °F (-40 to 70 °C)
    - Operating Humidity Range: 10-90% relative humidity
- **EMC Performance** - Complies with EN61326-1:2006.
- **Weight** - 10 lb. (4,54 kg)
- **Material of Construction**
    - Housing - Low-copper aluminum, NEMA 4X
    - Paint – Polyurethane
    - Cover Gasket - Silicone Rubber
    - Antenna - Remote Antenna: Fiber Glass
- **Certifications** - Class I Division 2 (U.S.), Equivalent Worldwide
- **Isolated RS485**
    - 2-wire communication link for Modbus RTU multidrop connections
    - Baud rate: 57600, 38400, 19200, or 9600
    - Protocol: Modbus RTU
    - Wiring: Single twisted shielded pair, 18 AWG. Wiring distance is approximately 4000 ft. (1,524 m)

- **Ethernet** - 10/100base-TX Ethernet communication port
    - Protocols: Modbus TCP, OPC, HART-IP, https (for Web Interface)
    - Wiring: Cat5E shielded cable. Wiring distance 328 ft. (100 m).
- **Modbus** - Supports Modbus RTU and Modbus TCP with 32-bit floating point values, integers, and scaled integers. Modbus Registers are user-specified.
- **OPC** - OPC server supports OPC DA v2, v3
- **Protocol** - IEC 62591(WirelessHART), 2.4 - 2.5 GHz DSSS.
- **Maximum Network Size**
    - 100 wireless devices @ 8 sec. or higher
    - 50 wireless devices @ 4 sec.
    - 25 wireless devices @ 2 sec.
    - 12 wireless devices @ 1 sec.
- **Supported Device Update Rates**
    - 1, 2, 4, 8, 16, 32 seconds or 1 - 60 minutes
- **Network Size/Latency**
    - 100 Devices: less than 10 sec.
    - 50 Devices: less than 5 sec.
- **Data Reliability** – Greater Than 99%
- **Ethernet**
    - Secure Sockets Layer (SSL) enabled (default) TCP/IP communications
- **Smart Wireless Gateway Access** - Role-based Access Control (RBAC) including:
    - Administrator, Maintenance, Operator, and Executive. Administrator has complete control of the Gateway and connections to host systems and the self-organizing network.
- **Self-Organizing Network**
    - AES-128 Encrypted WirelessHART, including individual session keys. Drag and Drop device provisioning, including unique join keys and white listing.
- **Internal Firewall**
    - User Configurable TCP ports for communications protocols, including Enable/Disable and user specified port numbers. Inspects both incoming and outgoing packets.
- **Third Party Certification**
    - Wurldtech: Achilles Level 1 certified for network resiliency National Institute of Standards and Technology (NIST): Advanced Encryption Standard (AES) Algorithm conforming to Federal Information Processing Standard Publication 197 (FIPS-197).

4.3 AIM® Wireless Gateway data interface



HART Tag	HART status	Last update	PV	SV	TV	QV	Burst rate
ST 1238		08/02/11 16:16:08	1.000 User Defined (240)	81.000 DegC	52.000 DegC	867.000 days	00:05:00
ST 1242		08/02/11 16:17:36	3.000 User Defined (240)	71.000 DegC	52.000 DegC	577.000 days	00:05:00
ST 1305		08/02/11 16:18:33	1.000 User Defined (240)	81.000 DegC	52.000 DegC	879.000 days	00:05:00

Table 11: AIM Wireless Gateway Interface Screenshot

Section 5: Field Network

5.0 Overview & Fundamentals

The AIM system uses a wireless mesh as described in Section 3 for communication. The gateways are capable of coordinating a network of up to 100 points. If there are more than 100 points within a monitored area, additional gateways will be needed and their networks will overlap.

5.1 Required Information

When installing the AIM system it is important to consider the location of the monitored points and the gateway and the possible communication paths while minding distances and obstructions. Typical communication distances are listed in Armstrong's AIM manual # IOM-256-A , page 2 of 16.

5.2 Best Practices

See "Designing a WirelessHART Network" in Armstrong's AIM manual # IOM-256-A, page 2 of 16.

5.3 Network Installation

The communication network will automatically form in the field when the transmitters are installed. It is important to remember that each network behaves individually. Therefore each network that is setup must have direct communication with the gateway associated with that particular network.

Section 6: HART Field Communicator

6.0 Overview & Fundamentals

The HART Field Communicator supports WirelessHART devices, letting the user to configure, maintain, or troubleshoot devices. The HART Field Communicator includes a color LCD touch screen, a Li-Ion battery (Power Module), a SH3 processor, memory components, System Card, and integral communication and measurement circuitry. The HART Field Communicator also supports multiple languages.

The HART Field Communicator is designed to operate with a wide range of WirelessHART devices independent of device manufacturer. Device interoperability is achieved through the Electronic Device Description Language (EDDL) technology supported by the HART Communication Foundation. Basic testing is performed on all device descriptions. Each device manufacturer is asked to certify that they thoroughly tested their devices with the HART Field Communicator. New device descriptions are available from the HART Field Communicator Easy Upgrade Utility or the Resource CD or DVD.

6.1 HART Field Communicator Specifications

PROCESSOR AND MEMORY

Microprocessor

- 80 MHz Hitachi® SH3

Memory Internal Flash

- 32 MB

System Card

- 1 GB secure digital card

RAM

- 32 MB

PHYSICAL

Weight

- Approximately 1.65 lb. (0.75kg) with battery

Display

- 1/4 VGA (240 by 320 pixels) color, 3.5 in. (8.9 cm) transflective display with touch screen
- Anti-glare coated

Keypad

- 25 keys including 4 action keys, 12 alphanumeric keys, tab key, function key, backlight key, power key, and 4 cursor-control (arrow) keys; membrane design with tactile feedback

POWER SUPPLY / CHARGER

Battery

- Rechargeable Lithium-Ion power module

Battery Operating Time

- 20 hours – continuous use
- 40 hours – typical use
- 80 hours – standby mode

Battery Charger Options

- Input voltage 100-240 VAC, 50-60 Hz
- Cables included with U.S., Europe, and U.K. plugs

CONNECTION

Battery Charger

- Mini DIN 6-pin jack

HART and Fieldbus

- Three 4mm banana jacks (one common to HART and FOUNDATION fieldbus)

IrDA Port

- IrDA (Infrared Data Access) port supporting up to 115 Kbps
- ±15 degrees recommended maximum angle from center line
- Approximately 18 in. (45.7 cm) recommended maximum distance

Bluetooth

- Up to 32.8 ft. (10 m) communication distance
- Uses standard Windows drivers
- FCC, IC, and CE approvals
- Certified for use in over 60 countries

ENVIRONMENTAL

Usage

- -10°C (14°F) to +50°C (122°F)
- 0% to 95% RH (non-condensing) for 0°C (32°F) to +50°C (122°F)

Charge

- 10°C (50°F) to +40°C (104°F)

Storage With Batteries

- -20°C (-4°F) to +55°C (131°F)

Storage Without Batteries

- -20°C (-4°F) to +60°C (140°F)

Enclosure Rating

- IP51 (from front)

Shock

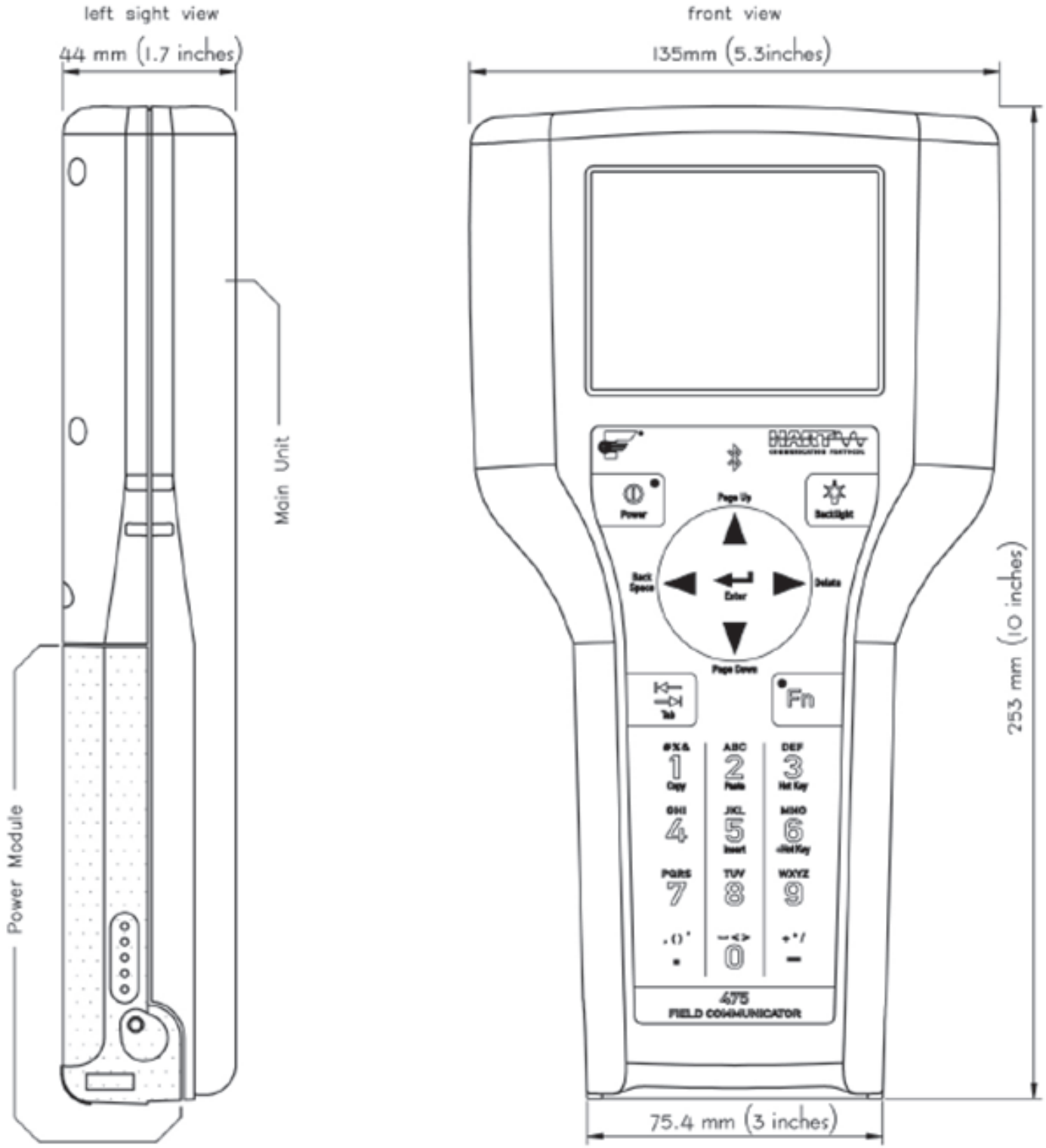
- Tested to survive a 1-meter drop test onto concrete

EASY UPGRADE REQUIREMENTS

Usage

- PC with Internet access
- CD Rom drive
- IrDA port (or adapter) or Bluetooth (or adapter)
- SD Card Reader (required for some upgrades)
- Windows XP (SP2 or SP3), Windows Vista Business (SP1), or Windows 7

6.2 HART Field Communicator Dimensions



Section 7: AIM® Monitor Software

7.0 Overview & Fundamentals

AIM® Monitor Software is an application based software that will poll multiple AIM® wireless gateways and compile the transmitted information into a single database. The AIM® software displays this information in easy to read symbols indicating trap and battery status.

7.1 AIM® Monitor Software Functionality/Description

Functionality: The AIM® software monitors and manages data from the AIM® wireless system. The gateways allow for only 100 points to be viewed, while AIM® software allows for a limitless number of points. By combining all of the gateways into one central location the user can manage all of the data for the entire system. AIM® software reduces the amount of time spent on monitoring systems by simplifying the output fields. The AIM® ST5700 output fields displayed in the gateways are: 1 = good trap, 2 = cold trap, and 3 = blow through trap. The Software translates the values it receives from the gateways and relays them as a trap status. Each trap status is expressed as an icon and a description.

Data connectivity issues, No Data Available, Device not configured and Out of Service are displayed in the trap status field so corrective action can be taken to restore communication.

Furthermore, the software notifies the battery status, Battery Good, Battery Low and Battery Critical.

Table 13: AIM® Software status legend

The software summarizes total quantities of trap status and displays to the right of each condition.

AIM® software can group traps together creating reporting groups. The reporting groups allow the user to organize monitoring points into areas for more finite analysis.

7.2 AIM® Monitor Software User Interface:

The AIM® software interface will display the information from the AIM® devices in the field in an easy to read pass/fail user interface. Large, easily identified icons are used allowing the user to quickly scan the trap population and identify steam trap failures.

- The steam trap monitoring points are displayed as such:
- Trap Tag # = Trap equipment number
- Trap Status = Symbol of the current trap status
- Temperature = Current Pipe Temperature at steam trap
- Trap Type = The generic type of steam trap
- Critical = Identification if trap is critical
- State Change Timestamp = Time at which the trap changed from the state it was previously, to the state it is currently
- Monitor Tag = Tag of the monitoring device
- Burst Rate = Identifies the transmission time intervals
- Monitor Status = Displays the current status of the monitoring device
- Battery Status = Symbol of the current battery condition
- Gateway = Identifies the gateway the monitoring device reports to

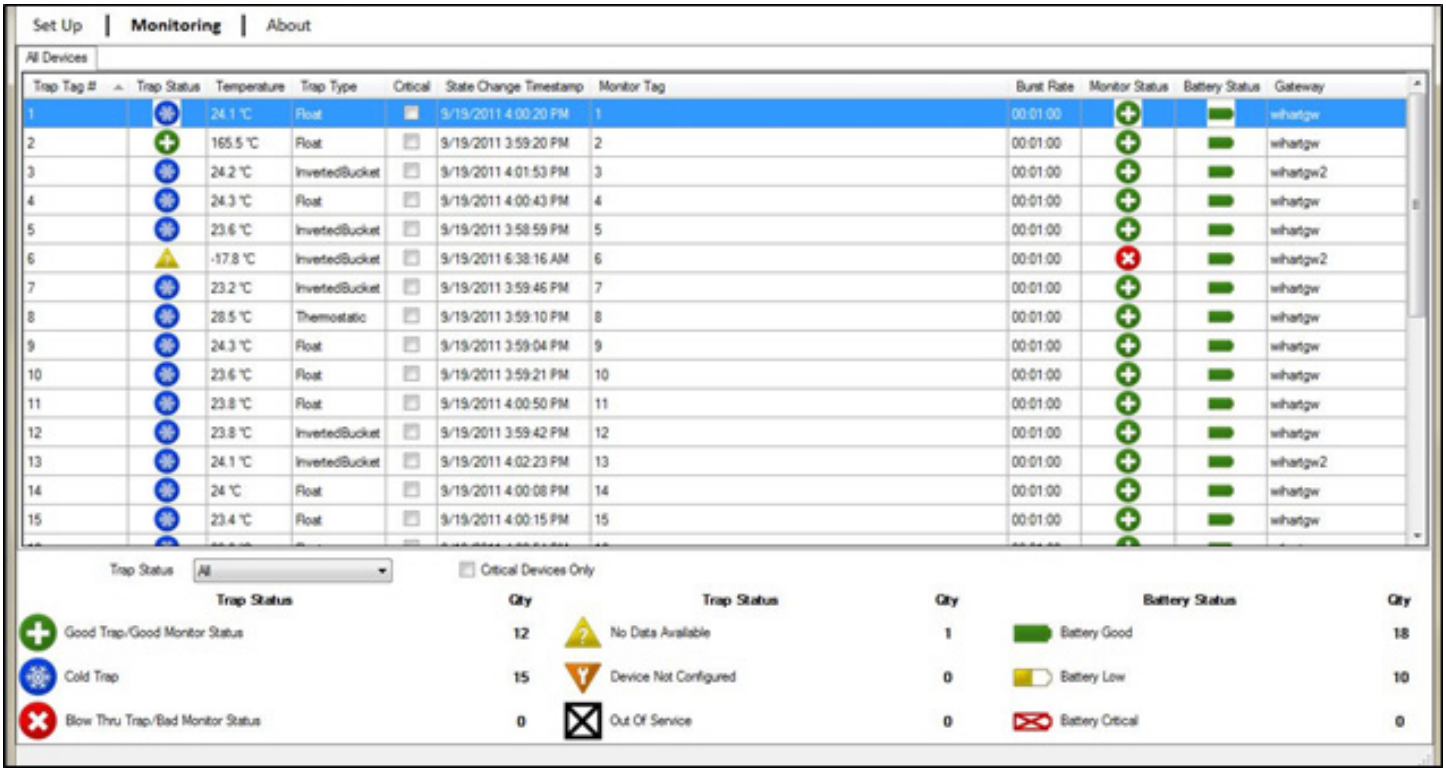


Table 14: AIM® Software User Interface

The AIM® software has a filter feature for equipment status allowing the user to quickly identify failed equipment or equipment in an alarm status.

7.3 AIM® Software System Requirements

Supported Microsoft Windows® Operating Systems

Windows 7 x86 (32-bit)	Yes
Windows 7 x64	Yes
Vista x86 (32-bit)	Yes
Vista x64	Yes
XP x86 (32-bit)	Yes
XP x64	Yes

Computer and Software Requirements:

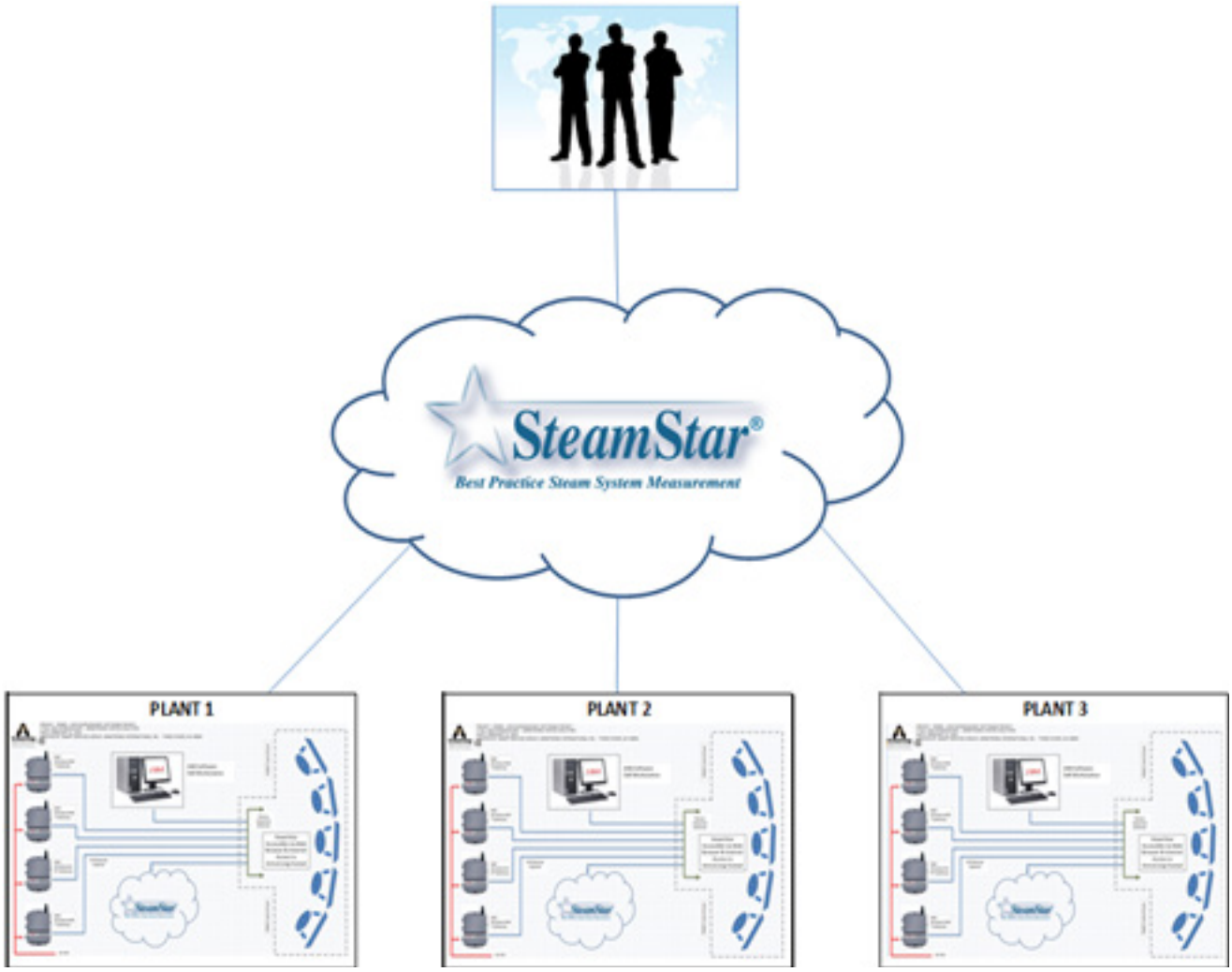
RAM	Minimum: 512 MB RAM Recommended: 1GB RAM
Software	Microsoft .NET Framework version 3.5 SP2 Microsoft SQL Server Compact 3.5 SP2 Microsoft Internet Explorer version 6.x or higher recommended Adobe Acrobat version 7.0.7 or higher
CPU	Intel® or AMD® processors Disk Space 2 GB free space
Other	DVD drive
Network	LAN TCP/IP network connection to the HartIP network.

Section 8: SteamStar®

8.0 Overview & Fundamentals

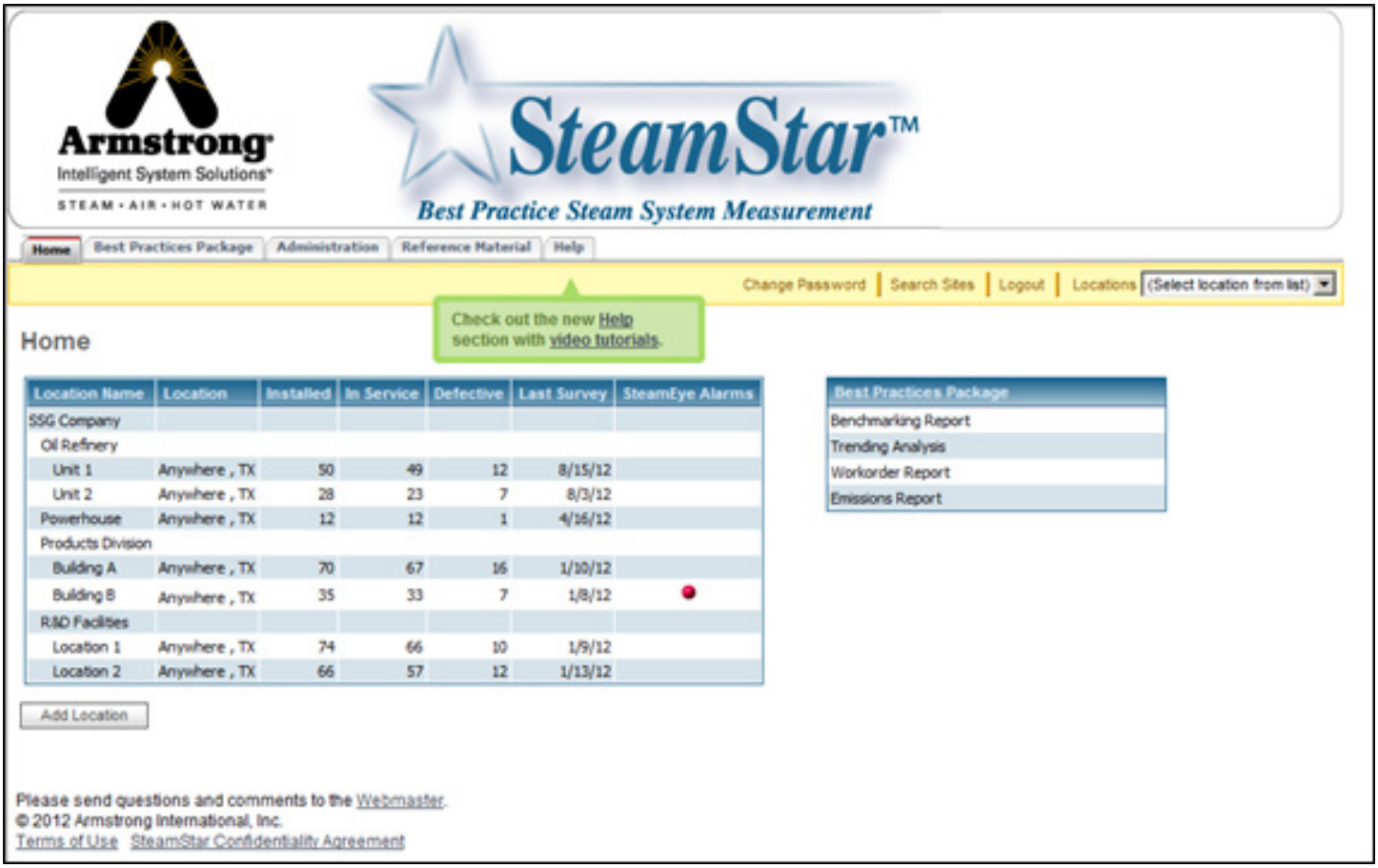
SteamStar® is an analytics software that manages single or multiple facilities steam assets and provides real time energy and emissions losses. The basic reporting package includes an executive summary, defective reports, recommendation reports, and complete log detail report. SteamStar® also has advanced reporting tools that provide benchmarking, trending, emissions, work order and multi-site reports. SteamStar® is used as an on-going maintenance tool to help manage steam assets and minimize energy losses by utilizing the AIM® wireless monitoring system to update the steam trap condition real-time. Once the steam trap is updated in the database from AIM®, SteamStar® calculates the energy losses based on the steam trap model, size, type, steam pressure, steam application and time in service. SteamStar® can be setup as a cloud hosted solution or as a client hosted solution.

If client hosted, SteamStar® can be used as a global reporting tool for steam asset management and maintenance.



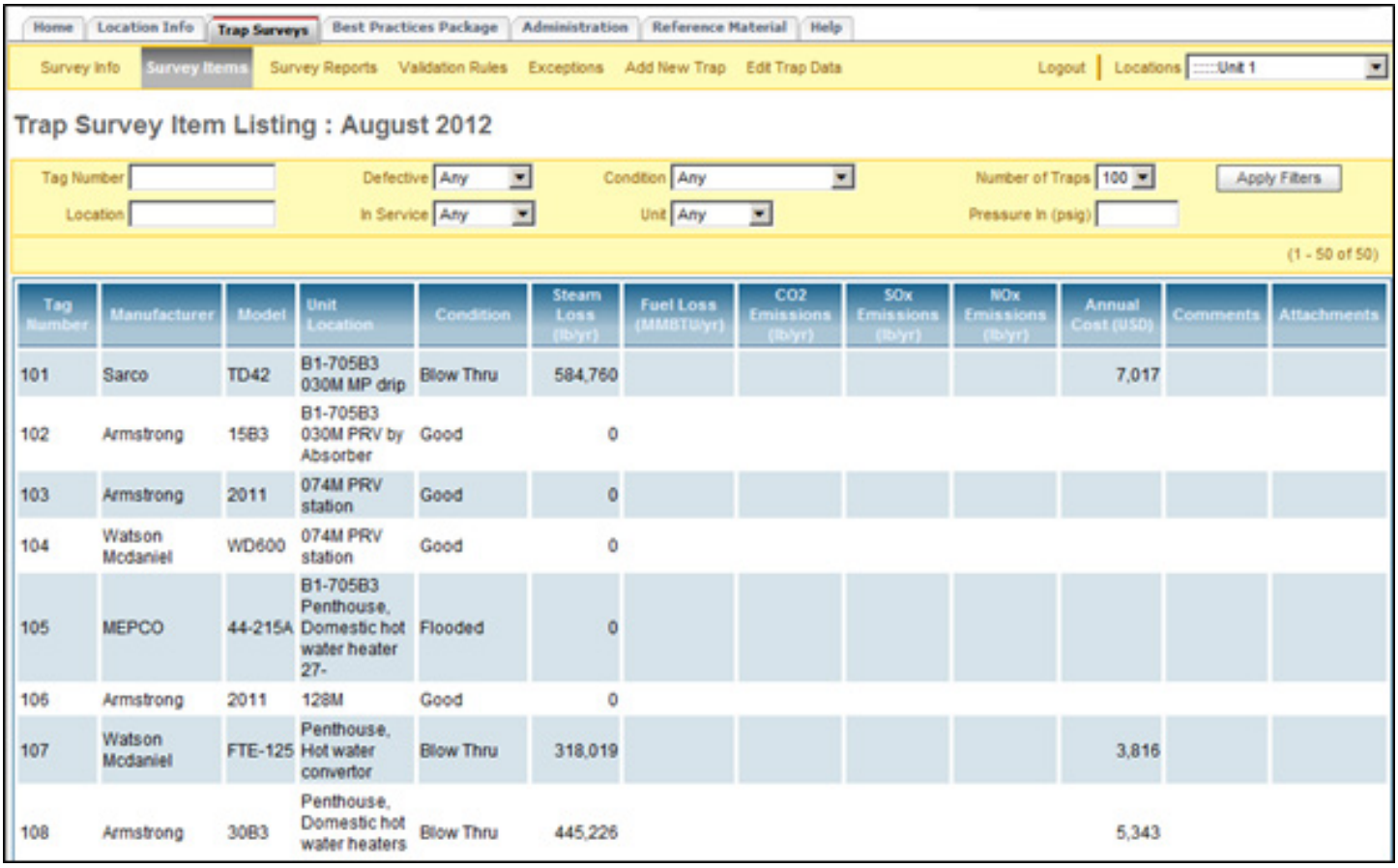
8.1 Software Homepage

The homepage is dashboard view of how all sub sites are performing.



8.2 Steam Asset Database

All steam assets can be tagged and tracked for real-time condition reporting.



Home | Location Info | Trap Surveys | Best Practices Package | Administration | Reference Material | Help

Survey Info | Survey Items | Survey Reports | Validation Rules | Exceptions | Add New Trap | Edit Trap Data | Logout | Locations: Unit 1

Trap Survey Item Listing : August 2012

Tag Number | Defective: Any | Condition: Any | Number of Traps: 100 | Apply Filters

Location | In Service: Any | Unit: Any | Pressure In (psig)

(1 - 50 of 50)

Tag Number	Manufacturer	Model	Unit Location	Condition	Steam Loss (lb/yr)	Fuel Loss (MMBTU/yr)	CO2 Emissions (lb/yr)	SOx Emissions (lb/yr)	NOx Emissions (lb/yr)	Annual Cost (USD)	Comments	Attachments
101	Sarco	TD42	B1-705B3 030M MP drip	Blow Thru	584,760					7,017		
102	Armstrong	15B3	B1-705B3 030M PRV by Absorber	Good	0							
103	Armstrong	2011	074M PRV station	Good	0							
104	Watson Mcdaniel	WD600	074M PRV station	Good	0							
105	MEPCO	44-215A	B1-705B3 Penthouse, Domestic hot water heater 27-	Flooded	0							
106	Armstrong	2011	128M	Good	0							
107	Watson Mcdaniel	FTE-125	Penthouse, Hot water convertor	Blow Thru	318,019					3,816		
108	Armstrong	30B3	Penthouse, Domestic hot water heaters	Blow Thru	445,226					5,343		

Steam Trap Data: All specific data pertaining to the steam trap can be databased:

- Tag Number
- Application
- Location
- Time in Use
- Manufacturer
- Model/Connection Size
- PMO (psig)
- Connection type
- Pressure In (psig)
- Pressure Out (psig)
- Condensate Load
- Piping Configuration
- Condition
  - OK = Good Trap
  - CD = Cold Trap
  - BT = Blow Through (Losing live steam)
  - LOS = Loss of Signal
  - RC = Rapid Cycling
  - PL = Plugged
  - OS = Out of Service
  - FL = Flooded
  - CC = Cycle Count
  - RA = Relief Alarm
  - OT = Over Temperature

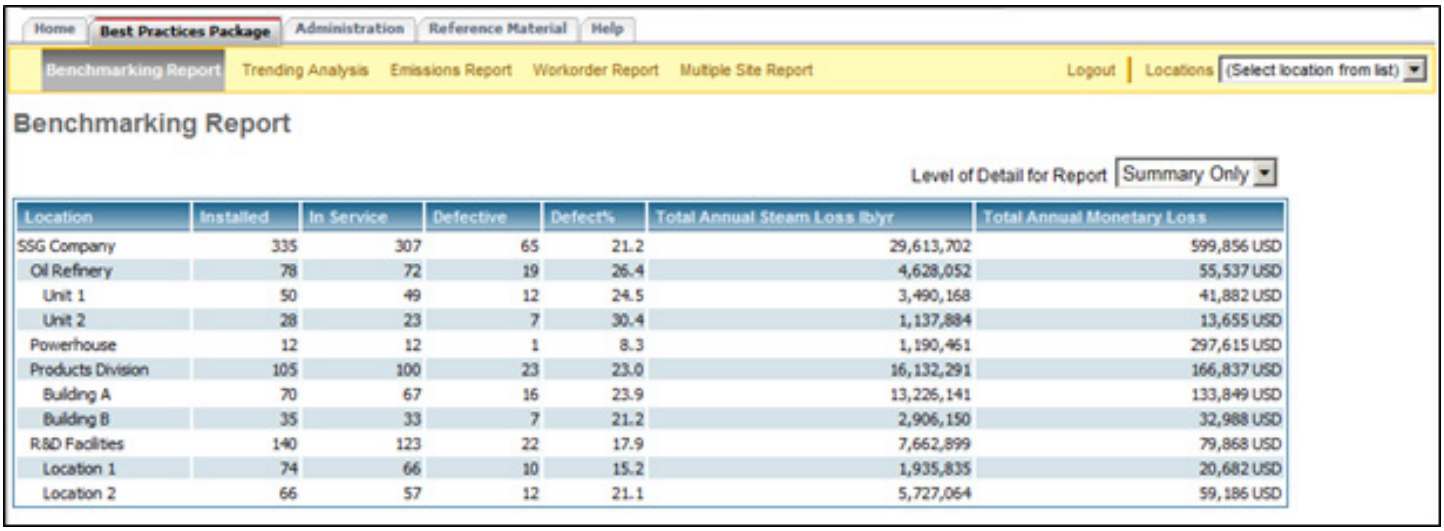
8.3 Global Setup (if desired)

Sites can be setup regionally, if desired for full global access view or limited site access view based on access.

Location Name	Location	Installed	In Service	Defective	Last Survey	SteamEye Alarms
Andover Food						
Asia						
Andover Guangzhou	Guangzhou , Guangdong	246	218	23	11/26/04	
Andover Jakarta	Tangerang , Banten	10	10	2	2/26/08	
Andover Klang	Klang	50	50	14	10/17/04	
Andover Philippines	Cagayan De Oro	3	3	1	10/9/12	
Andover Seoul	Seoul	3	3	3	8/2/06	
EMEA						
Andover Croatia	Zagreb	997	997	131	4/12/04	
Andover France	Marseille	1,093	1,093	107	3/31/10	
Andover Germany	Hamburg	815	815	336	3/15/05	
Andover London	London				2/17/07	
Andover Oman	Muscat					
Andover Slovakia	Bratislava	652	652	61	8/12/04	
Andover UK	Southampton	27	27	11	11/16/07	
North America					3/31/10	
Andover Canada	Toronto , QC	10	10	8	3/6/06	
Andover Mexico	Mexico City	9	9	8	3/20/06	
U.S. Central Region						
Baytown Texas	Baytown , TX	1,630	1,630	409	10/2/04	
Corpus Christi Texas	Corpus Christi , TX	46	46	14	2/11/09	
Dallas Texas	Dallas , TX	75	70	37	6/26/06	
Phillipsburg, KS	Phillipsburg , KS	544	544	115	6/18/08	
U.S. East Coast Region						
Bradford, PA	Bradford , PA	465	465	79	8/10/04	
Elkton, VA	Elkton , VA	50	50	8	11/1/08	
Paulsboro, NJ	Paulsboro , NJ	816	816	336	8/2/04	
Whitehouse Station	Whitehouse Station , NJ	1	1	1	11/1/12	
U.S. Midwest Region					8/17/07	
Akron Ohio	Akron , OH	47	47	11	5/12/04	
Findlay Ohio	Findlay , Ohio					
Joliet Illinois	Joliet , IL	3,260	3,260	816	10/17/04	
Lansing Michigan	Lansing , MI					
Three Rivers, MI	Three Rivers , MI	36	36	15	1/15/06	
U.S. West Coast Region						
Los Angeles, CA	Los Angeles , CA	815	815	336	1/5/05	
Oakland, CA	Oakland , CA	543	543	118	4/22/05	
Portland, OR	Portland , OR	1,087	1,087	165	7/12/09	
San Diego, CA	San Diego , CA	1	1	1	7/25/09	

8.4 Benchmarking Reports

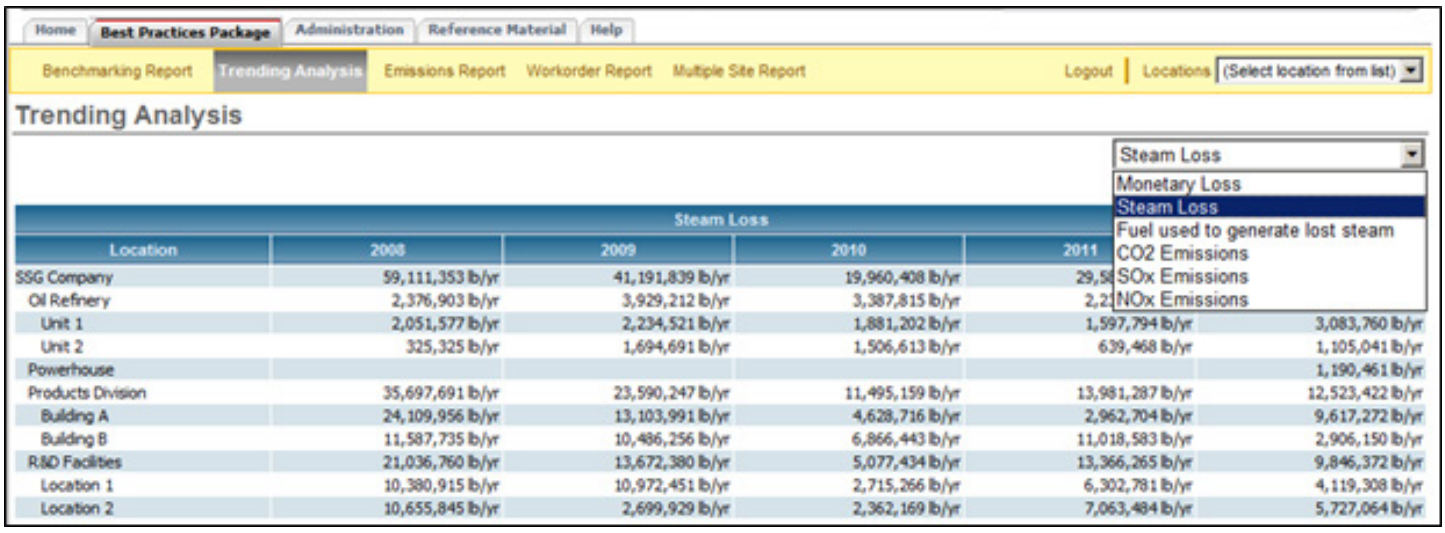
Reports can be summarized by Application, Manufacturer, Generic Type or Equipment Condition



Location	Installed	In Service	Defective	Defect%	Total Annual Steam Loss lb/yr	Total Annual Monetary Loss
SSG Company	335	307	65	21.2	29,613,702	599,856 USD
Oil Refinery	78	72	19	26.4	4,628,052	55,537 USD
Unit 1	50	49	12	24.5	3,490,168	41,882 USD
Unit 2	28	23	7	30.4	1,137,884	13,655 USD
Powerhouse	12	12	1	8.3	1,190,461	297,615 USD
Products Division	105	100	23	23.0	16,132,291	166,837 USD
Building A	70	67	16	23.9	13,226,141	133,849 USD
Building B	35	33	7	21.2	2,906,150	32,988 USD
R&D Facilities	140	123	22	17.9	7,662,899	79,868 USD
Location 1	74	66	10	15.2	1,935,835	20,682 USD
Location 2	66	57	12	21.1	5,727,064	59,186 USD

8.5 Trending Analysis

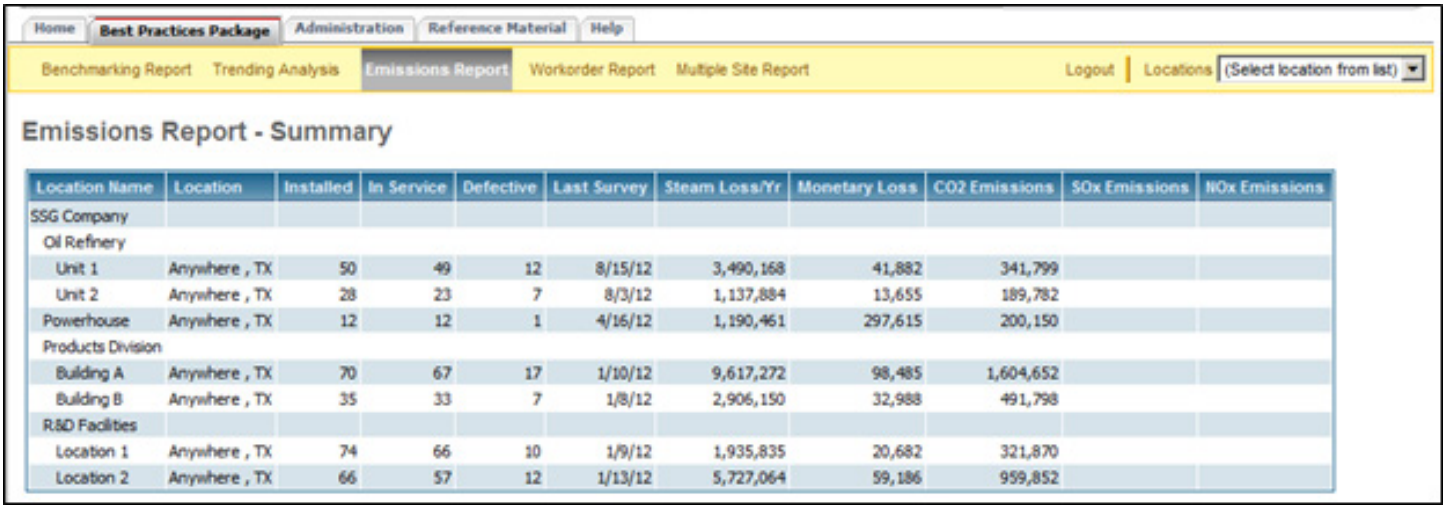
View performance trends over time. Report can be summarized by steam loss, monetary loss or emissions loss.



	Steam Loss				
Location	2008	2009	2010	2011	
SSG Company	59,111,353 lb/yr	41,191,839 lb/yr	19,960,408 lb/yr	29,5	
Oil Refinery	2,376,903 lb/yr	3,929,212 lb/yr	3,387,815 lb/yr	2,2	
Unit 1	2,051,577 lb/yr	2,234,521 lb/yr	1,881,202 lb/yr	1,597,794 lb/yr	3,083,760 lb/yr
Unit 2	325,325 lb/yr	1,694,691 lb/yr	1,506,613 lb/yr	639,468 lb/yr	1,105,041 lb/yr
Powerhouse					1,190,461 lb/yr
Products Division	35,697,691 lb/yr	23,590,247 lb/yr	11,495,159 lb/yr	13,981,287 lb/yr	12,523,422 lb/yr
Building A	24,109,956 lb/yr	13,103,991 lb/yr	4,628,716 lb/yr	2,962,704 lb/yr	9,617,272 lb/yr
Building B	11,587,735 lb/yr	10,486,256 lb/yr	6,866,443 lb/yr	11,018,583 lb/yr	2,906,150 lb/yr
R&D Facilities	21,036,760 lb/yr	13,672,380 lb/yr	5,077,434 lb/yr	13,366,265 lb/yr	9,846,372 lb/yr
Location 1	10,380,915 lb/yr	10,972,451 lb/yr	2,715,266 lb/yr	6,302,781 lb/yr	4,119,308 lb/yr
Location 2	10,655,845 lb/yr	2,699,929 lb/yr	2,362,169 lb/yr	7,063,484 lb/yr	5,727,064 lb/yr

8.6 Emissions Report

Emissions Report gives you a summary of your steam trap population as well as steam loss, monetary loss and emissions loss.

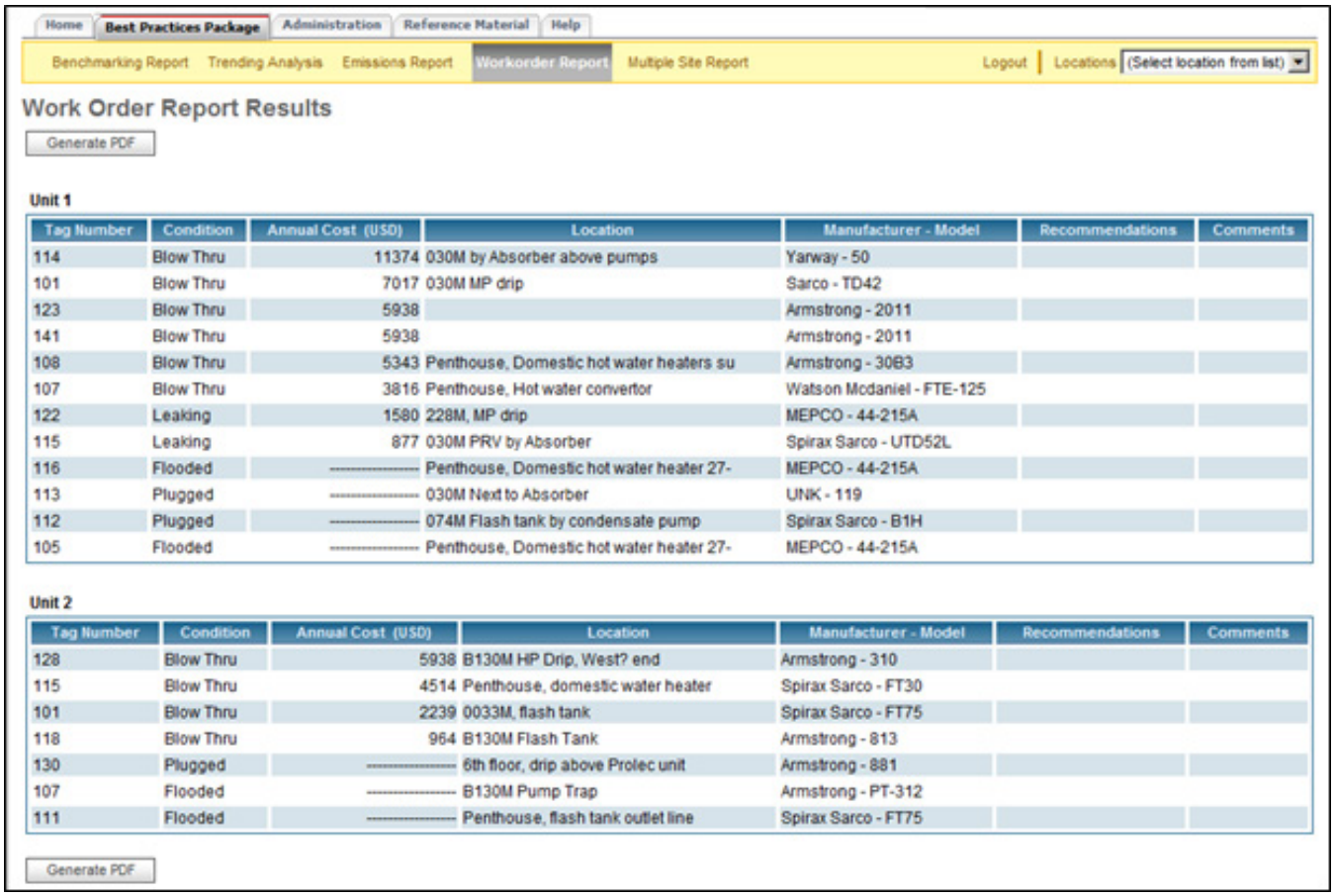


Emissions Report - Summary

Location Name	Location	Installed	In Service	Defective	Last Survey	Steam Loss/Yr	Monetary Loss	CO2 Emissions	SOx Emissions	NOx Emissions
SSG Company										
Oil Refinery										
Unit 1	Anywhere , TX	50	49	12	8/15/12	3,490,168	41,882	341,799		
Unit 2	Anywhere , TX	28	23	7	8/3/12	1,137,884	13,655	189,782		
Powerhouse	Anywhere , TX	12	12	1	4/16/12	1,190,461	297,615	200,150		
Products Division										
Building A	Anywhere , TX	70	67	17	1/10/12	9,617,272	98,485	1,604,652		
Building B	Anywhere , TX	35	33	7	1/8/12	2,906,150	32,988	491,798		
R&D Facilities										
Location 1	Anywhere , TX	74	66	10	1/9/12	1,935,835	20,682	321,870		
Location 2	Anywhere , TX	66	57	12	1/13/12	5,727,064	59,186	959,852		

8.7 Work Order Maintenance Report

Users can create work order maintenance reports based on energy loss priority.



Work Order Report Results

Generate PDF

Unit 1

Tag Number	Condition	Annual Cost (USD)	Location	Manufacturer - Model	Recommendations	Comments
114	Blow Thru	11374	030M by Absorber above pumps	Yarway - 50		
101	Blow Thru	7017	030M MP drip	Sarco - TD42		
123	Blow Thru	5938		Armstrong - 2011		
141	Blow Thru	5938		Armstrong - 2011		
108	Blow Thru	5343	Penthouse, Domestic hot water heaters su	Armstrong - 30B3		
107	Blow Thru	3816	Penthouse, Hot water convertor	Watson Mcdaniel - FTE-125		
122	Leaking	1580	228M, MP drip	MEPCO - 44-215A		
115	Leaking	877	030M PRV by Absorber	Spirax Sarco - UTD52L		
116	Flooded	----------	Penthouse, Domestic hot water heater 27-	MEPCO - 44-215A		
113	Plugged	----------	030M Next to Absorber	UNK - 119		
112	Plugged	----------	074M Flash tank by condensate pump	Spirax Sarco - B1H		
105	Flooded	----------	Penthouse, Domestic hot water heater 27-	MEPCO - 44-215A		

Unit 2

Tag Number	Condition	Annual Cost (USD)	Location	Manufacturer - Model	Recommendations	Comments
128	Blow Thru	5938	B130M HP Drip, West? end	Armstrong - 310		
115	Blow Thru	4514	Penthouse, domestic water heater	Spirax Sarco - FT30		
101	Blow Thru	2239	0033M, flash tank	Spirax Sarco - FT75		
118	Blow Thru	964	B130M Flash Tank	Armstrong - 813		
130	Plugged	----------	6th floor, drip above Prolec unit	Armstrong - 881		
107	Flooded	----------	B130M Pump Trap	Armstrong - PT-312		
111	Flooded	----------	Penthouse, flash tank outlet line	Spirax Sarco - FT75		

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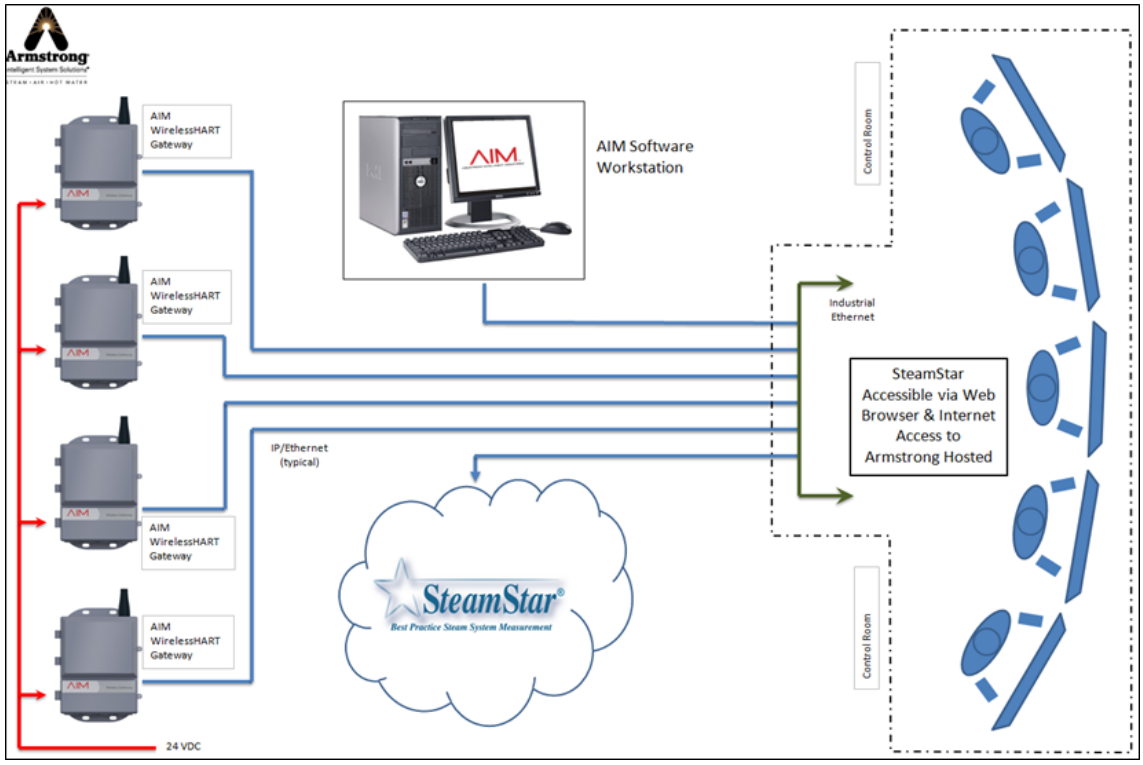
Section 9: System Architecture Samples

Cloud Hosted



Client Hosted