ORNL/TM-2016/733

Summary of Industrial Energy Systems Training and Certification Programs

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OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

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Energy and Transportation Science Division

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Date Published: November 8, 2016

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, TN 37831-6283
managed by
UT-BATTELLE, LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

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ACRONYMS

AEE	Association of Energy Engineers
ANSI	American National Standard Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ATMT	American Trainco Maintenance Technician
BCAS	British Compressed Air Society
BPMA	British Pump Manufacturers Association
CAC	Compressed Air Challenge
CAGI	Compressed Air and Gas Institute
CARO	Certified Assistant Refrigeration Operator
CEU	Continuing Education Unit
CHP	Combined Heat and Power
CIBSE	Chartered Institution of Building Services Engineers
CIGC	Chartered Industrial Gas Consultant
CIRO	Certified Industrial Refrigeration Operator
CO2	Carbon Dioxide
CRES	Certified Refrigeration Energy Specialist
DGCP	Distributed Generation Certified Professional
DipCAM	Diploma in Compressed Air Management
DOE	Department of Energy
GTI	Gas Technology Institute
HI	Hydraulic Institute
IEAP	Insulation Energy Appraisal Program
IHEA	Industrial Heating Equipment Association
IIAR	International Institute of Ammonia Refrigeration
NH3	Ammonia
PSM	Process Safety Management
RAI	RETA Authorized Instructor
RCGC	Registered Commercial Gas Consultant
RETA	Refrigerating Engineers & Technicians Association
RMP	Risk Management Plan
SSO	Steam System Optimization
TAP	Ten Action Points
UK	United Kingdom
UNIDO	United Nations Industrial Development Organization
US	United States
USA	United States of America

ACKNOWLEDGEMENTS

The authors would like to thank Mahabir Bhandari and Jennifer Travis, both of Oak Ridge National Laboratory, who assisted in the development and review of this report.

EXECUTIVE SUMMARY

Compressed air system, industrial refrigeration system, chilled water system, pump system, fan system, steam system, process heating system, and combined heat and power system are the major industrial energy systems. By helping enhance knowledge and skills of workforce, training and certification programs on these systems are essential to improve energy efficiency of manufacturing facilities. A literature survey of currently available training and certification programs on these systems was conducted.

This document includes the summary of current available training and certification programs on the above-mentioned industrial energy systems. The major findings are presented as follows:

- **Compressed Air System**: the major training providers are Compressed Air Challenge (CAC), Compressed Air and Gas Institute (CAGI), and British Compressed Air Society (BCAS). There are also some engineering consulting firms and equipment manufacturers and vendors providing trainings to meet their clients' specific needs. Qualified AIRMaster+ Specialist by CAC and US DOE, Diploma in compressed air management (DipCAM) by BCAS, and Certificate on Compressed Air System Technology by BCAS are the three major certifications. None of these three certifications are ANSI certified. CAGI is developing the certification of Certified Practitioner, which is intended to be ANSI certified.
- **Industrial Refrigeration System**: community colleges and training companies are the major training providers. These training programs are mainly structured to help participants to be Refrigerating Engineers & Technicians Association (RETA) certified operators and energy specialists. The major certifications are provided by RETA and they are Certified Assistant Refrigeration Operator (CARO), Certified Industrial Refrigeration Operator (CIRO), Certified Refrigeration Energy Specialist (CRES), and RETA Authorized Instructor (RAI). CARO and CIRO are ANSI certified. International Institute of Ammonia Refrigeration (IIAR) has an ANSI/IIAR 2-2014 Certificate Program, which focuses on the safe design of closed-circuit ammonia refrigeration systems.
- **Chilled Water System**: American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), University of Wisconsin–Madison, and chiller manufactures are the major training providers. Most of the training programs focus on the design of chilled water systems and provide Continuing Education Units (CEUs) but no certification has been found.
- **Pump System**: There are numerous trainings provided by manufacturers and vendors covering various facets of pump system. Hydraulic Institute (HI), FlowServe, and British Pump Manufacturers Association (BPMA) provide trainings concentrated on the whole pump system's energy efficiency. HI currently has one certification called Pump System Assessment. HI is also developing Pump System Assessment Master certification, which is planned to be ANSI certified. British Pump Manufacturers Association has a certification program called Certified Pump System Auditor.
- **Fan System**: Similar to pump system, many manufactures and vendors provide training programs on installation, operation and maintenance. A training program focusing on fan system energy efficiency is Fan System Assessor Certification Training provided by United Nations Industrial Development Organization (UNIDO). The Fan System Assessor Certification by UNIDO seems to be the only certification on fan system.
- **Steam System**: U.S. Department of Energy provides steam end users best practice and specialist qualifications trainings. UNIDO provides two levels of Steam System Optimization (SSO) training programs: user and expert. Equipment manufactures also provide various trainings for their clients. TAP your Steam System and Steam System Specialist training programs provided by Swagelok Energy Service seem very well structured. Qualified Steam Tool Specialist by U.S. DOE and UNIDO, and ATMT Certified Qualified Boiler Operator by TPC Trainco are the two major certifications.

- **Process Heating System**: Industrial Heating Equipment Association (IHEA) and Gas Technology Institute (GTI) provide training programs on fundamentals of process heating, understanding of many industrial process heating technologies, and energy efficiency of new and existing process heating technologies. John Zink Company provides a series of courses on fundamentals of different furnaces and burners, process heating energy assessments, burner operators. No certifications had been found.
- **Combined Heat and Power System**: Association of Energy Engineers (AEE) and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) are the two major USA based CHP training providers. Some universities and training companies also have some workshops for co-generation system. These workshops cover the design, operation, and maintenance of CHP system. The only CHP related certification is provided by the Distributed Generation Certified Professional (DGCP) provided by AEE.

The above major observations are further condensed in Table 1 for a quick reference.

Table 1. Industrial energy systems major training and certification programs

Energy Systems	Major Non-profit Training Providers	Certifications
Compressed Air System	Compressed Air Challenge	Qualified AIRMaster+ Specialist (CAC and US DOE)
	Compressed Air and Gas Institute	Certificate on Compressed Air System Technology (BCAS)
	British Compressed Air Society	Diploma in compressed air management (DipCAM) (BCAS)
Industrial Refrigeration System	Community Colleges	Certified Assistant Refrigeration Operator (CARO) (RETA; ANSI Certified)
		Certified Industrial Refrigeration Operator (CIRO) (RETA; ANSI Certified)
		Certified Refrigeration Energy Specialist (CRES) (RETA)
		RETA Authorized Instructor (RAI) (RETA)
Chilled Water System	American Society of Heating, Refrigerating and Air-Conditioning Engineers	None
	University of Wisconsin–Madison	
Pump System	Hydraulic Institute	Pump System Assessment (HI)
	British Pump Manufacturers Association	Pump System Assessment Master (HI; In Development)
		Certified Pump System Auditor (BPMA)
Fan System	United Nations Industrial Development Organization	Fan System Assessor (UNIDO)
Steam System	U.S. Department of Energy	Qualified Steam Tool Specialist (U.S. DOE and UNIDO)
	United Nations Industrial Development Organization	ATMT Certified Qualified Boiler Operator (TPC Trainco)
Process Heating System	Industrial Heating Equipment Association	None
	Gas Technology Institute	

Table 1. (continued)

Energy Systems	Major Non-profit Training Providers	Certifications
Combine Heat and Power System	American Society of Heating, Refrigerating and Air-Conditioning Engineers	Distributed Generation Certified Professional (AEE)
	Association of Energy Engineers	

In summary, several training programs had been found on these industrial energy systems. However, majority of them are about fundamentals, design, installation and maintenance. Only a few focuses on energy efficiency. Compressed air system, industrial refrigeration system, pump system, fan system, steam system, and combined heat and power system have energy assessment and energy efficiency focused certifications. No similar certifications had been found for chilled water system or process heating system. None of these energy assessment or energy efficiency focused certifications seem to be ANSI certified.

1. INTRODUCTION

It is well known that good quality training programs are very critical to maintain and improve competencies of workforce. Certification programs are designed to objectively measure professionals' knowledge and skills in certain fields. Certification programs also provide a mechanism to encourage professionals to strategically improve their expertise and obtain new skill sets.

Compressed air system, industrial refrigeration system, chilled water system, pump system, fan system, steam system, process heating system, and combined heat and power system are the major industrial energy systems. The primary objective of this document is to summarize the current available training and certification programs focused on these energy systems. The major findings are summarized in the following sections.

2. COMPRESSED AIR SYSTEM

Compressed air system training programs are mainly provided by three types of organizations: non-profit trade associations, training companies, air compressor manufacturers and vendors. These training programs are summarized in Table 2.

Table 2. Compressed air system training programs summary

Provider	Program Title	Training Length	Training Format
Compressed Air Challenge (USA)	Fundamentals of Compressed Air Systems	1 Day	Classroom
	Advanced Management of Compressed Air Systems	2 Days	Classroom
	Qualified AirMaster+ Specialists	2.5 Days	Classroom + Field Training
	Compressed Air, It's Not Free!	1 Hour	Not Sure
Compressed Air and Gas Institute (USA)	Smart Site	4 to 8 Hours	Online
British Compressed Air Society (UK)	Working safely with compressed air	1 Hour	Online
	Compressed air system technology	Not Sure	Online
	Diploma in compressed air management (DipCAM)	50 hours	Online
National Cleaner Production Centre (South Africa)	Compressed Air System Optimization	2 Days	Not Sure
http://www.pdhonline.com/ (USA)	7 Courses	2 - 6 hours	Online

Table 2. (continued)

Provider	Program Title	Training Length	Training Format
Festo Didactic Training & Consulting (USA)	Introduction to Energy Saving on Compressed Air Systems	Not sure	Not Sure
Compressed Air Solutions (USA)	No Official Title	Not Sure	Not Sure
Ingersoll Rand (USA)	No Official Title	Not Sure	Not Sure
UE Systems (USA)	Compressed Air Survey Course	Not Sure	Not Sure
National Compressed Air (Canada)	No Official Title	Not Sure	Not Sure
Air Technology (UK)	No Official Title	Not Sure	Classroom + Field Training
Air Compressor Guide (UK)	Compressed Air Confidence	Not Sure	Not Sure
	Compressed Air Mastery	Not Sure	Not Sure
Sullair (Australia)	No Official Title	Not Sure	Classroom + Field Training

Compressed Air Challenge (CAC) and **Compressed Air and Gas Institute (CAGI)** are the two major compressed air industry associations in the United States. Compressed Air Challenge currently offers the following four training programs: Fundamental of Compressed Air Systems, Advanced Management of Compressed Air Systems, AirMaster+ Specialist Qualification (teamed with US DOE), and "Compressed Air, It's Not Free!". Compressed Air and Gas Institute's training program is called Smart Site, which is a series of eight online e-learning modules to explore various facets of compressed air. The eight modules include: Compressed Air Basics, Types of Compressors, Capacity Controls, Distribution Systems, Controlling Wastes, Air Treatment, Compressor Installation & Air System Maintenance, and Integrally Geared Centrifugal Compressors.

The British Compressed Air Society (BCAS) is the UK's leading compressed air and vacuum trade association and it provides three training programs: Working Safely with Compressed Air, Compressed Air System Technology, and Diploma in Compressed Air Management (Dipcam). Working Safely with Compressed Air is a 1-hour online training session to show compressed air users how to work safely and understand the risks involved if good practice is not followed. Compressed Air System Technology has 10 modules and provides a comprehensive introduction to the main principles and uses of modern compressed air systems. Diploma in compressed air management (DipCAM) training program takes six months to complete and involves up to 50 hours of study. This training program has 10 modules.

www.PDHonline.com provides seven online courses about compressed air system: Compressed Air Energy Storage (4-hour), Compressed Air Systems (4-hour), Introduction to Industrial Compressed Air Systems (2-hour), Improving the Performance of Compressed Air Systems (3-hour), Compressed Air Energy Efficiency (6-hour), Air Compressors – Basic Concepts and Application (2-hour) and An Introduction to Compressed Air Systems (2-hour). Further details on the contents can be found at www.PDHonline.com after registration. Festo Didactic Training & Consulting located at UK provides a 1-day classroom training program called "Introduction to Energy Saving on Compressed Air Systems". This course covers Air Leaks - Costs, Sources and Finding, Practices to Reduce the Risk of Air Leaks, Effects of Leaks on Machine Performance, Component Sizing, System Design to Minimize Air Leaks.

Some air compressor manufacturers and vendors, for example, Compressed Air Solutions (US), National Compressed Air (Canada), Ingersoll Rand (US), Sullair Australia, Air Technology (UK), and UE Systems (US), provide training sessions to educate their clients on general compressed air knowledge and their

products and services. Typically, these training sessions can be tailored to meet their clients' specific needs.

The certifications on compressed air system are presented in Table 3.

Table 3. Compressed air system certifications

Provider	Certification	Exam Format	Focus	ANSI Certified
Compressed Air Challenge	Qualified AIRMaster+ Specialist	Practical and written exams	Use of AIRMaster+ and System Optimization	No
British Compressed Air Society	Diploma in compressed air management (DipCAM)	Written exam	Not Sure	No
British Compressed Air Society	Certificate on Compressed air system technology	No exam	Not Sure	No
Compressed Air and Gas Institute	Certified Practitioner[1]	Not Sure	Not Sure	Planned

[1] In development; has not been officially announced yet.

3. INDUSTRIAL REFRIGERATION SYSTEM

Industrial refrigeration system training programs are mainly provided by three types of organizations: community colleges, training companies focusing on ammonia systems, and engineering consulting firms. These training programs are summarized in Table 4.

Table 4. Industrial refrigeration system training programs summary

Provider	Program Title	Training Length	Training Format
Garden City Community College (USA)	Industrial NH3 Refrigerator Operator I	7 Days	Classroom + Field Training
	Industrial NH3 Refrigerator Operator II	7 Days	Classroom + Field Training
	Industrial NH3 Refrigeration Technician 1 (Operator III)	7 Days	Classroom + Field Training
	Industrial NH3 Refrigeration PSM/RMP	7 Days	Classroom + Field Training
	Advanced Refresher / RETA CIRO Prep	7 Days	Classroom + Field Training
Lanier Technical College (USA)	Ammonia for Non-Operators	1 Day	Classroom + Field Training
	Industrial Refrigeration Operator Refresher	2 Days	Classroom + Field Training
	Industrial Ammonia Refrigeration Level I	4 Days	Classroom + Field Training

Table 4. (continued)

Provider	Program Title	Training Length	Training Format
	Industrial Ammonia Refrigeration Level II	4 Days	Classroom + Field Training
	Industrial Ammonia Refrigeration Level III - Technical	4 Days	Classroom + Field Training
	Maintenance & Troubleshooting for Refrigeration Operators	4 Days	Classroom, Field Training (Not Sure)
	PSM / RMP for Ammonia Operator	4 Days	Classroom, Field Training (Not Sure)
Polk State College (USA)	Refrigeration Review Course	1 Day	Classroom, Field Training (Not Sure)
	Introduction to Ammonia Refrigeration	1 Day	Classroom, Field Training (Not Sure)
	Refrigeration Principles Level 1	4 Days	Classroom, Field Training (Not Sure)
	Refrigeration Principles Level 2	4 Days	Classroom, Field Training (Not Sure)
	Refrigeration Principles Level 3 - Maintenance & Troubleshooting	4 Days	Classroom, Field Training (Not Sure)
	Refrigeration Principles Level 4	4 Days	Classroom, Field Training (Not Sure)
	Energy Optimization for Ammonia Refrigeration	3 Days	Classroom, Field Training (Not Sure)
Northwest Technical Institute (USA)	Ammonia Refrigeration Operator Training 1	Not Sure	Not Sure
	Ammonia Refrigeration Operator Training 2	Not Sure	Not Sure
	Ammonia Refrigeration Operator Training 3	Not Sure	Not Sure
	Ammonia Refrigeration Operator Training	2 Semesters	Not Sure
	Refrigeration Principles Level 2	4 Days	Classroom, Field Training (Not Sure)
	Refrigeration Principles Level 3 - Maintenance & Troubleshooting	4 Days	Classroom, Field Training (Not Sure)
	Refrigeration Principles Level 4 (RETA, BE1, BE2)	4 Days	Classroom, Field Training (Not Sure)
	Energy Optimization for Ammonia Refrigeration	3 Days	Classroom, Field Training (Not Sure)

Table 4. (continued)

Provider	Program Title	Training Length	Training Format
Industrial Refrigeration Technical College (USA)	Ammonia Refrigeration	3 Days	Classroom + Field Training
	Industrial Refrigeration Operator 1	4.5 Days	Classroom + Field Training
	Industrial Refrigeration Operator 2	4.5 Days	Classroom + Field Training
	Industrial Refrigeration Operator 3	4.5 Days	Classroom + Field Training
	Industrial Refrigeration Energy Specialist	4.5 Days	Classroom, Field Training (Not Sure)
	CO2 Refrigeration	3 Days	Classroom + Field Training
Nh3jobs Training	Industrial Refrigeration Level 1	55 Hours	Pre-recorded
	Industrial Refrigeration Level 2	66 Hours	Pre-recorded
	Energy Efficiency Level 1	66 Hours	Pre-recorded
Industrial Consultants, LLC (USA)	Level I Ammonia Refrigeration Operator Training	32 hours	Classroom + Field Training
	Level II Refrigeration Operator Training	40 hours	Classroom + Field Training
	RETA CIRO Prep	24 hours	Classroom + Field Training
Envirosure Solutions LLC (USA)	CARO Training	Not Sure	Not Sure
	CIRO Training	Not Sure	Not Sure
Danfoss (USA)	Industrial Refrigeration Training	Not Sure	Online
Office of Environment and Heritage (OEH) (Australia)	Energy efficient commercial refrigeration	15 mins for online, 0.5 days for workshop	Online + Classroom
M&M Refrigeration (USA)	Introduction to Cascade CO2/NH3 Refrigerating Systems	2 Days	Classroom + Field Training
University of Wisconsin–Madison (USA)	Introduction to Ammonia Refrigeration Systems	3 Days	Classroom
	Intermediate Ammonia Refrigeration Systems	3 Days	Classroom
	Design of Ammonia Refrigeration Systems for Peak Performance and Efficiency	5 Days	Classroom
	Ammonia Refrigeration System Safety	3 Days	Classroom

Table 4. (continued)

Provider	Program Title	Training Length	Training Format
	Principles and Practices of Mechanical Integrity for Industrial Refrigeration Systems	3 Days	Classroom
	Process Hazard Analysis Emphasizing Ammonia Refrigeration Systems	3 Days	Classroom
International Institute of Ammonia Refrigeration (IIAR)	IIAR Certificate Program	8 Hours	Online

Garden City Community College, Lanier Technical College, Polk State College, and Northwest Technical Institute are four community colleges providing industrial refrigeration training programs. These training programs include basic introduction on industrial refrigeration system, industrial refrigeration system operation, and process hazards and safety training. These courses are also structured to help prepare participants to become Refrigerating Engineers and Technicians Association (RETA) certified ammonia system operators and energy specialists.

Industrial Refrigeration Technical College and NH3 Jobs Training are two training companies with focus on industrial refrigeration systems. Their courses are designed very similarly to the ones provided by the above-mentioned community colleges. Industrial Consultants, LLC and Envirosure Solutions LLC are two engineering consulting firms who not only provide engineering service, but also training on industrial refrigeration system.

Department of Engineering Professional Development at University of Wisconsin–Madison provides a set of courses to cover the basics, principle, design, safety and hazard analysis of industrial refrigeration systems. International Institute of Ammonia Refrigeration (IIAR) provides training to help participants to get certified on ANSI/IIAR 2-2014 American National Standard for the Safe Design of Closed-Circuit Ammonia Refrigeration Systems.

Danfoss and M&M Refrigeration provide training on basics of refrigeration systems and their products. The certifications on industrial refrigeration system are shown in Table 5.

Table 5. Industrial refrigeration system certifications

Provider	Certification	Exam Format	Focus	ANSI Certified
Refrigerating Engineers and Technicians Association (RETA)	CARO – Certified Assistant Refrigeration Operator	Practical and written exams	Operation and Safety	Yes
	CIRO – Certified Industrial Refrigeration Operator	Practical and written exams	Operation and Safety	Yes

Table 5. (continued)

Provider	Certification	Exam Format	Focus	ANSI Certified
	CRES — Certified Refrigeration Energy Specialist	Not sure	Energy Efficiency	No
	RAI —RETA Authorized Instructor	Not sure	Teaching/Training	No
International Institute of Ammonia Refrigeration (IIAR)	ANSI/IIAR 2-2014 Certificate Program (American National Standard the Safe Design of Closed-Circuit Ammonia Refrigeration Systems)	Not sure	Design	Not sure

4. CHILLED WATER SYSTEM

Chilled water system training programs are mainly provided by non-profit organizations (trade associations, government agents, and universities), training companies and chiller manufacturers. These training programs are summarized in Table 6.

Table 6. Chilled water system training programs summary

Provider	Program Title	Training Length	Training Format
ASHRAE (USA)	Fundamentals of Water System Design (including both heating water and chilled water systems)	35 Hours	Pre-recorded
University of Wisconsin–Madison (USA)	Chilled Water Plant Design	3 Days	Classroom
The Chartered Institution of Building Services Engineers (CIBSE) (UK)	Design of Heating and Chilled Water Pipe Systems	7 Hours	Classroom
BCA Academy (Singapore)	Measurement & Verification of Central Chilled-Water Plant Efficiency	3.5 Days	Classroom + Field Training
EPIC Educational Program Innovations Center (Canada)	Design and Operation of Chilled Water Plants	Not Sure	Classroom
NTT Training (USA)	Chillers: Operation & Maintenance of Chilled Water Systems	3 Days	Classroom + Field Training
trainup.com (USA)	Chilled Water Systems	2 Days	Classroom
Decatur Professional Development (USA)	HVAC Chilled Water Distribution Schemes	5 Hours	Online
Northwest Regional Industrial Training (USA)	Energy Efficiency of Chilled Water Systems	1 Day	Not Sure

Table 6. (continued)

Provider	Program Title	Training Length	Training Format
TPC Trainco (USA)	Chilled Water Systems	2 Days	Online
LP Management Services (USA)	Energy Efficient Chilled Water Systems Design	8 Hours	Not Sure
Carrier (USA)	Applied Water System Design CSD 700	5 Days	Classroom + Field Training
Daikin (USA)	Daikin Air & Water-Cooled Screw Chiller Maintenance, Operation & Service Course	4.5 Days	Classroom + Field Training
Trane (USA)	Chilled Water Systems Technical Service Training	Not Sure	Not Sure

ASHRAE, University of Wisconsin–Madison, and The Chartered Institution of Building Services Engineers (CIBSE) are the three major non-profit organizations providing trainings on the design of chilled water system. Carrier, Trane and Daikin are the three major chiller manufacturers training providers.

It can be observed that most of the training programs are more focused on the design of chilled water systems. Only a few (e.g. two training programs by Northwest Regional Industrial Training) are more concentrated on the energy efficiency aspect of chilled water system.

No chilled water system related certifications, either design, operation, or energy efficiency focused, had been found.

5. PUMP SYSTEM

Numerous pump training programs had been found. The majority of these programs are provided by pump manufacturers and vendors with focus on various aspects of pumps, e.g., basics on hydraulic systems, pump components (seals, drive, lubrication, vibration, etc.), installation, operation and maintenance. These manufacturers and vendors also provide tailored training to meet their clients' needs. The various training programs on Pump System are listed in Table 7 and the Pump System certifications are listed in Table 8.

Table 7. Pump system training programs (system efficiency focused only) summary

Provider	Program Title	Training Length	Training Format
Hydraulic Institute (USA)	Pump Systems Assessment	Must be completed within 60 days of registration	Online
British Pump Manufacturers Association (UK)	Certified Pump System Auditor	4 Days	Classroom + Field Training
FlowServe (USA)	Pump System Analysis	3 – 4 Days	Classroom + Lab Training
Manufacturers and Vendors	Many training programs with focus on pump components and operations	Varies	Not Sure

Table 8. Pump system certifications

Provider	Certification	Exam Format	Focus	ANSI Certified
Hydraulic Institute	Pump System Assessment	Written	System assessment	No
	Pump System Assessment Master [2]	Written	System assessment	Planned
British Pump Manufacturers Association	Certified Pump System Auditor	Written	System assessment	No

[2] In development

Hydraulic Institute (HI), FlowServe, and British Pump Manufacturers Association provide training concentrating more on the whole pump system's energy efficiency. HI currently has one certification called Pump System Assessment. HI is also developing Pump System Assessment Master certification, which is planned to be ANSI certified. British Pump Manufacturers Association has a certification program called Certified Pump System Auditor. These training programs only include written exams.

6. FAN SYSTEM

Like pump system, many manufactures and vendors provide training programs on installation, operation and maintenance (Table 9). The only training program found that is focusing on fan system energy efficiency is Fan System Assessor Certification Training by UNIDO. The Fan System Assessor Certification by UNIDO is the only found certification about fan system.

Table 9. Fan system training programs summary

Provider	Program Title	Training Length	Training Format
UNIDO	Fan System Assessor Certification Training	10 days over a 1-year period	Classroom + Field Training
Productive Energy Solutions	Fan Assessment	Depending on module	Online
Twin City Fan Companies (USA)	Fan Engineering I - The basics	1 Day	Classroom Only
	Fan Engineering II - Advanced	1 Day	Classroom Only

7. STEAM SYSTEM

U.S. DOE provides steam end users best practice and specialist qualifications trainings. UNIDO provides two levels of Steam System Optimization (SSO) training programs: user and expert. The SSO USER training is primarily targeted to facility engineers, boilers/steam systems operators and maintenance staff of enterprises and the SSO EXPERT training is primarily targeted to national energy efficiency consultants, steam system equipment vendors and other providers of energy efficiency services to industry. State Energy Conservation Office of the Texas offers a workshop on steam and cogeneration system assessment. Gas Technology Institute has a 2-day course to cover essential understanding of complex industrial steam generation and in-plant distribution. The American Society of Mechanical Engineers (ASME) has a 2-day course focusing on boiler operation and maintenance.

Spirax Sarco, TLV, Cleaver Brooks, Armstrong International, and Swagelok are the major equipment manufacturers providing both generic steam system training programs and customized trainings to meet their clients' specific needs. It is worth noting that the TAP your Steam System and Steam System Specialist training programs provided by Swagelok Energy Service seem very well structured.

There are also some engineering consulting firms offering training programs on the fundamental and optimization of steam systems. Table 10 shows the summary of Steam System training programs.

Table 10. Steam system training programs summary

Provider	Program Title	Training Length	Training Format
Department of Energy (USA)	Best Practices - Steam End User Training	1 Day	Not Sure
	Specialist Qualification Training	2.5 Days	Classroom
United Nations Industrial Development Organization (UNIDO) (Austria)	Industrial Steam Systems Optimization - USER Training	2 Days	Classroom
	Industrial Steam Systems Optimization - Expert Training	5 Days	Classroom + Field Training
The American Society of Mechanical Engineers (ASME) (USA)	Boiler Operation and Maintenance	2 Days	Classroom
State Energy Conservation Office of the Texas (USA)	Steam and Cogeneration System Assessment Workshop	7 Hours	Classroom
Gas Technology Institute (USA)	Industrial Steam Systems	2 Days	Offsite classroom course with flexibility to be held on-site with customized content
Spirax Sarco (UK)	Fundamentals of Steam Utilization	1 Day	Classroom and live demonstrations
	Clean Steam Utilization	1 Day	Classroom and live demonstrations
	Carbon Reduction and Energy Efficient Steam Systems	1 Day	Classroom and live demonstrations
	On-site and Custom Training	Customizable	Classroom + Field Training
Swagelok Energy Advisors (USA)	Steam System Optimization	1 Day	Classroom
	TAP your Steam System - Level I	1 Day	Classroom + Field Training

Table 10. (continued)

Provider	Program Title	Training Length	Training Format
	TAP your Steam System - Level II	1 Day	Classroom + Field Training
	Steam System Specialist - Level I	3 Days	Classroom + Field Training
	Steam System Specialist - Level II	3 Days	Classroom + Field Training
	Steam System Specialist - Level III	3 Days	Classroom + Field Training
	Custom In-Plant Training	Customizable	Classroom + Field Training
TLV (Japan)	Steam and Condensate Training Seminar	2 Days	Classroom and Demonstrations
Cleaver Brooks in association with Armstrong International (USA)	Empowering Steam Best Practices	2 Days	Classroom
Cleaver Brooks (USA)	On-Site Training	Customizable	Classroom + Field Training
Armstrong International (USA)	College of Steam - Generation	~5 - 6 hours	Online
	College of Steam - Distribution	~5 - 6 hours	Online
	College of Steam - Users	~5 - 6 hours	Online
Campbell-Sevey (USA)	Steam Energy Conservation Seminar	1 Day	Classroom and Demonstrations
Affliated Steam and Hot water (USA)	Steam Fundamentals Seminar	1 Day	Classroom and Demonstrations
	Hands On Seminars on Steam System	1 Day	Classroom and Demonstrations
Carotek (USA)	Steam Technology Basics	1 Day	Classroom and Demonstrations
UE Systems	Steam Trap Examiner, Level I Course	2 Days	Classroom + Field Training
	Steam System Optimization	1.5 Days	Classroom + Field Training
Babcock & Wilcox	Technical Training Seminar - Boiler 101	1 Day	Classroom and live demonstrations
	On-Site Training	Customizable	Classroom + Field Training
	Mobile Training Facilities	Customizable	Classroom
Hudson technologies (USA)	Best Practices Training	Fundamental - 1 Day, Advanced - 2 days, Expert - 3 Days	Classroom + Field Training

Table 10. (continued)

Provider	Program Title	Training Length	Training Format
EMV3 Consulting (USA)	Professional Training - Energy System Optimization	Customizable	Classroom + Field Training
Hughes Machinery (USA)	Steam Basics	1 Day	Classroom and Demonstrations
	Advanced Steam Topics	1 Day	Classroom and Demonstrations
Boiler Efficiency Institute, LLC (USA)	Boiler and Steam System	2 Days	Classroom + Field Training
TPC Trainco (USA)	Boiler Operation, Maintenance & Safety	2 Days	Classroom + Field Training
	Steam Systems Maintenance, Safety & Optimization	2 Days	Classroom + Field Training

Most of the training programs provide Certificate of Completion. However, only two certifications on steam system had been found: Qualified Steam Tool Specialist by U.S. DOE and UNIDO, and ATMT Certified Qualified Boiler Operator by TPC Trainco (Table 11).

Table 11. Steam system certifications

Provider	Certification	Exam Format	Focus	ANSI Certified
DOE	Qualified Steam Tool Specialist	Written	System Optimization	No
UNIDO	Qualified Steam Tool Specialist	Written	System Optimization	No
TPC Trainco	ATMT Certified Qualified Boiler Operator	Written	Boiler Operation & Maintenance	No

8. PROCESS HEATING SYSTEM

Several training programs are available on process heating system. A summary of these training programs are listed in Table 12.

Table 12. Process heating system training programs summary

Provider	Program Title	Training Length	Training Format
Industrial Heating Equipment Association (IHEA) (USA)	Fundamentals of Process Heating On-Line Course	6 Time Week	Online
	On-line video trainings in the industrial process heating industry	20 – 40 minutes each video	Online
Gas Technology Institute (USA)	Efficient Gas Technologies	2-days or 15 hours	Classroom

Table 12. (continued)

Provider	Program Title	Training Length	Training Format
Gas Technology Institute (USA)	Chartered Industrial Gas Consultant (CIGC) and Registered Commercial Gas Consultant (RCGC)	Multiple Days	Classroom + Field Training
National Insulation Association (USA)	Insulation Energy Appraisal Program (IEAP)	2 Days	Classroom
John Zink Company Inc.	Cracking Furnaces – Reaction and Combustion Fundamentals	Not sure	Classroom
	Process Burners Fundamentals	Not sure	Classroom + Field Training
	Fundamentals of Reforming Furnaces	Not sure	Classroom
	Process Heating Energy Assessment	2.5 Days	Classroom + Field Training
	Process Burner Operator Training	3 Days	Classroom + Field Training
Seventh Wave and We Energies (USA)	Industrial heat recovery: reduce, recycle and reuse	1 Day	Classroom

The training programs provided by Industrial Heating Equipment Association (IHEA) are focused on fundamentals of process heating and understanding of many industrial process heating technologies. The two training courses provided by Gas Technology Institute are more concentrated on energy efficiency of new and existing process heating technologies. National Insulation Association provides a 2-day professional certification course that instructs students to determine the optimal insulation thickness and corresponding energy and dollar savings for a project.

John Zink Company provides fundamental courses on cracking furnaces, process burners, and reforming burners. It also provides training on process heating energy assessments and burner operators.
Seventh Wave and We Energies provide a training course focusing on industrial heat recovery.
No certifications had been found focusing on process heating systems either for equipment operators, designers, or energy efficiency specialists.

9. COMBINED HEAT AND POWER SYSTEM

Association of Energy Engineers (AEE) and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) are the two major USA based CHP training providers. Some universities and training companies also have some workshops for co-generation system. These workshops cover the design, operation, and maintenance of CHP system. Table 13 lists the major training programs available around the world.

Table 13. Combined heat and power system training programs summary

Provider	Program Title	Training Length	Training Format
AEE (USA)	Basics of Distributed Generation & Onsite CHP	2 Days	Classroom
	Small-Scale Cogeneration Online Seminar	6 hours of material covered over 3 days via 3 X 2 hour sessions	Online
ASHRAE (USA)	Cogeneration from the Basics through Construction & Operation	6 Hours	Classroom
	Combined Heat and Power: Creating Efficiency through Design & Operations	3 Hours	Classroom
Cranfield University (UK)	Combined Heat and Power: An Integrated Approach to Energy Resources	5 Days	Classroom
The European Energy Center (UK)	Combined Heat and Power - One Day workshop	1 Days	Classroom
IFP Training (France)	Cogeneration - Combined Cycles - Waste Heat Recovery	3 Days	Classroom + Field Training
The Training Center (USA)	Cogeneration Seminar	1 Day	Classroom and live demonstrations
Renovetec (Spain)	Operation and Maintenance of Cogeneration Power Plants	24 hours	Classroom + Field Training
NYU - School of Professional Studies (USA)	Combined Heat and Power	7 Hours	Classroom
360Training (USA)	Co-Generation and other Turbine Cycles	4 Hours	Online

The only found CHP related certification is the Distributed Generation Certified Professional (DGCP) provided by AEE.