

Jamaica's HPMP Implementation Project (UNDP component)

Final Report

on

Two 1-Day Workshops

concerning

Capacity Building of RAC Industry Senior Managers on

Alternatives to HCFCs

by

Earle Wilson, PhD - National Consultant

August 2020

Table of Contents

List of Acronyms	3
Executive Summary	4
Report on Activities Implemented, Lessons Learnt and Recommendations	5
Introduction	5
Background	5
Objectives	6
Training Methodology	6
Participants	6
Structure and Topics	7
Practicum	9
Assessment	10
Evaluation	10
Information provided to participants	10
Lessons Learned	11
Recommendations	11
Conclusion	13
Appendices:	14
Appendix 1: Pictures from workshops	15
Appendix 2: Registers and Test Results	18
Appendix 3: Workshop Evaluation Survey	23
Appendix 4: Information for Pamphlets on New and Emerging Refrigerants	26
Appendix 5: List of key reference documents	31

LIST OF ACRONYMS

HPMP	Hydro-chloro-fluoro-carbons Phase-out Management Plan
HCFC	Hydrochlorofluorocarbons
MLF	Multilateral Fund
RAC	Refrigeration and Air Conditioning
UNDP	United Nations Development Programme

EXECUTIVE SUMMARY

This report outlines the activities implemented, lessons learnt, conclusions reached and recommendations made arising from the Kingston based two 1-day workshops regarding capacity building of refrigeration and air conditioning (RAC) industry Senior Managers on alternatives to hydrochlorofluorocarbons (HCFCs) refrigerants. The workshops targeted forty (40) managers across the island.

These workshops are part of the ongoing strategies in the implementation of Jamaica's HCFC Phase-out Management Plan (HPMP). Specifically, they address a crucial intervention which is to provide capacity building to the refrigeration and air conditioning service industry as it transitions from the use of HCFCs refrigerants to the new and emerging alternatives.

From the lessons learnt, the following recommendations are considered as enabling the continued success in the implementation of the HPMP:

- The COVID-19 impact on attendance necessitates Workshops for Senior Managers outside of Kingston.
- Workshops for Senior Managers outside of Kingston should be zoned. Eastern, Mid-Island and Western zones.
- Informational Workshops, especially for Managers, should be executed in no more than 4 hours.
- A choice of Morning or Afternoon slot should be offered where possible.
- Folders given to Participants should be appropriately labelled with details on the Workshop, i.e. Title, Date, Location and Presenter's profile.
- Devise means for mass circulation of glossed, folded, pamphlets on New and Emerging Refrigerants with Applications

Report on Activities Implemented, Lessons Learnt, Conclusion and Recommendations

INTRODUCTION

This report provides information on two 1-day workshops held in Kingston on August 17 and 24, 2020 for senior managers in the Refrigeration and Air Conditioning (RAC) sector.

The objective of the workshops is capacity building on present and emerging alternative refrigerants to hydrochlorofluorocarbons (HCFCs), with the scope of the training covering the major RAC sub-sectors.

Background

The Hydro-chloro-fluoro-carbons Phase-out Management Plan (HPMP) for Jamaica is ongoing with assistance from the Multilateral Fund (MLF). The purpose of the HPMP is to assist the Government of Jamaica with phasing out HCFCs for the refrigeration and air-conditioning (RAC) sector.

The HPMP Project requires Jamaica to examine alternative and emerging technologies and to ensure that the necessary framework is in place to allow the RAC sector to respond to the staged phase-out of hydro-chloro-fluoro-carbons (HCFCs).

The explicit objective of this training programme is to build the capacity of RAC Industry senior managers on environmentally friendly alternatives to HCFCs.

The training includes topics on global policies and developments in seven (7) refrigeration and air conditioning sub-sectors.

Objectives

The main objectives of the Workshop are:

- i. To highlight the specific impact of the Montreal Protocol on the refrigeration and air conditioning (RAC) sector
- ii. To highlight the effect of the Kyoto Protocol on existing refrigerants
- iii. To emphasise the combined influence of Montreal and Kyoto (Kigali) Protocols on the international refrigerant trade
- iv. To provide relevant data on new and emerging refrigerant replacements to seven main RAC Industry sub-sectors
- v. To aid senior managers in their decision making on refrigerant replacement choices
- vi. To emphasise, through demonstration, the need to periodically test the composition of imported refrigerants

Methodology Employed to achieve Objectives:

PowerPoint presentations with discussions on the significant points, followed by hands-on exercises, were the methods used to achieve the objectives.

Participants

It must be noted that the national COVID-19 restrictions negatively affected attendance.

Cancellations were made overnight by attendees from outside of Kingston.

The workshops had twenty-one senior managers/supervisors attending over the two days, where two-thirds fall in the category of Business and Maintenance. The others are in Consulting and Purchasing. Not surprising, two-thirds are in the age group 36 years and above.

The interactions were mainly through questions concerning the impact of trends in new and emerging refrigerants on the Jamaican RAC sector. Concerns about current stocks of HCFCs were alleviated by the fact that these will not be banned until 2040. Participants conveyed appreciation for the information that maps each HCFC to its specific replacement in the various sub-sectors.

The attendees were excited to participate in the demonstration on Refrigerants Identification. They were both awed and concerned to know that the labels and colour codes on refrigerants cylinders do not necessarily guarantee the contents. The managers planned on doing random Identification tests on their bulk imports.

Structure, Topics with Emphases

Structure:

The workshops were structured as two complete 3 hours sessions per day; 9 am to 12 noon and 1 pm to 4 pm. This arrangement satisfied the government COVID-19 guidelines on ‘social distancing’ and the number of persons in any given space. The aim was to have ten persons per session.

Topics and Emphases:

Montreal Protocol

- Depletion of the Ozone Layer
- The Ozone “hole”
- Substances that deplete the ozone layer
- How HCFCs destroy the ozone layer

Kyoto Protocol

- Global Warming
- Greenhouse effect
- Substances that aid global warming

Effects of Kyoto and Montreal Protocols on New and Emerging Refrigerants

- Reduction in ODP and GWP

The Way Forward

- Four Main Routes to Replacing HCFCs in the RAC Sector
- Safety Grouping of Refrigerants
- General Refrigerant Alternatives

New and Emerging refrigerants for Specific Application

- Commercial refrigeration application
 - Centralised systems
 - Condensing units
- Industrial refrigeration application
- Stationary air conditioning application
 - Moveable room AC
 - Single split AC
 - Multi-split AC/VRF
 - Chiller
 - Heat pump
- Shipping Vessels refrigeration application
 - Refrigerated Sea Water (RSW)
 - “Freezing” (plate freezers and blast tunnels)
 - “Others” (ice-makers, small brine chillers, air-coolers for bait, storage hold)

PRACTICUM

- Analysis of Refrigerants Composition

Workshop Assessment

Participants engaged in Pre and Post-tests. This exercise was to gauge the uptake from the presentations. The tests consist of 12 questions related to the material presented, wherein the questions cover the two broad areas of Environmental and HCFCs and their Alternatives. (see appendix 2, pg 18)

Workshop Evaluation

The general feedback about the Workshop was positive with most scores (16/21) in the very good/excellent range (see Evaluation in appendix 3, pg 23); and for the specific overall ranking, 14/21 scored in the very good category.

Information provided to participants

The PowerPoint information presented was given to the participants on jump-drives.

Additional materials handed out were:

- KIGALI Amendment to the Montreal Protocol: Impact on the RAC Sector in Jamaica
- KIGALI Amendment: Institutional Structure
- KIGALI Amendment to the Montreal Protocol: The Impact on refrigerant use and consumption in Jamaica
- Process Flow Chart for Importation of HCFCs

Lessons Learned

The following are general lessons learnt from conducting these Workshops:

- The 3-hours packaged Workshops are more convenient than the all-day versions for Senior Managers.
- The choice of Morning or Afternoon timeslot was also a winner; even though some attendees switched timeslots at the last moment.
- While attendees had a general awareness of the changes taking place in the RAC field regarding refrigerants, only a few had a comprehensive understanding of the specific new and emerging refrigerants applications.
- The inclusion of a practical session on Refrigerant Analyzer and its Application was a big success. For some Managers, it immediately solved their problem of how to address customers complaints of being sold 'bad gas'.
- An observation made is that folders given to Participants should be appropriately labelled with details on the Workshop; i.e. Title, Date, Location and Presenter's profile.

Recommendations

The following are recommendations made to assist further the aims of the HPMP after these two Workshops:

- The COVID-19 impact on attendance necessitates Workshops for Senior Managers outside of Kingston.
- Workshops for Senior Managers outside of Kingston should be zoned. Eastern, Mid-Island and Western zones.

- Informational Workshops, especially for Managers, should be executed in no more than 4 hours.
- A choice of Morning or Afternoon slot should be offered where possible.
- Folders given to Participants should be appropriately labelled with details on the Workshop; i.e. Title, Date, Location and Presenter’s profile.
- Devise means for mass circulation of glossed, folded, pamphlets on New and Emerging Refrigerants with Applications (See example below, and for the complete set, see Appendix 4, pg 25).

Stationary: Moveable room AC:

(Devices that are hermetically sealed and can be moved between rooms by the user. Mostly used in private households.)

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R407A, R410A
HFCs	R32	675	-	A2L	R407A, R410A

CONCLUSION

The Managers stated their appreciation for the workshops and the information shared, giving them updates on refrigerants development. They gave thumbs-up for the practical on the refrigerant analyser and planned on incorporating it in their businesses.

Of concern to them is the knowledge that colour codes that previously guarantee contents is no longer the case in this present international trade and that customs officers are not necessarily focusing on this issue.

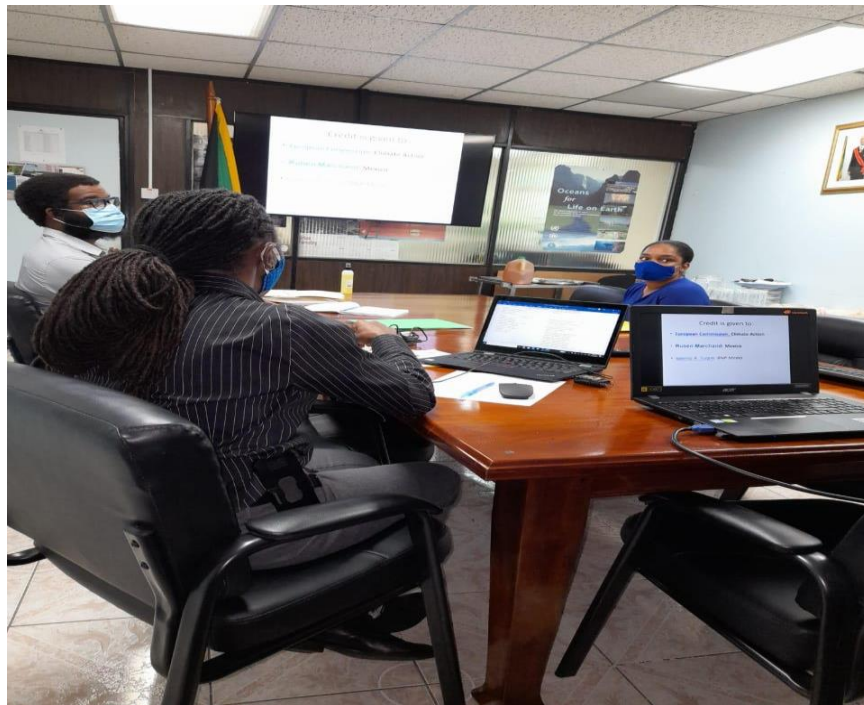
The positive reception of the participants to the material shared indicates that other Managers in the RAC industry across the island should be so updated.

APPENDICES

APPENDIX 1: SCENES FROM WORKSHOP



(9 AM – 12 NOON: AUGUST 17, 2020)



(9 AM – 12 NOON: AUGUST 24, 2020)



(1 PM – 4 PM : AUGUST 24, 2020)



(1 PM – 4 PM : AUGUST 17, 2020)



(9 AM – 12 NOON: AUGUST 17, 2020)

APPENDIX 2: Register & Test Results

APPENDIX 2: REGISTER & Tests Results						Test
Results						
	Names	Company Name	Contact	E-Mail	Pre Test	Post Test
1	Andrew Wright	Red Stripe	550-1388	Andrew.wright@heineken.com	7/12	9/12
2	David Barrett	Enbar Consulting	342-9996	dbarrett@gmail.com	7/12	10/12
3	Orville Lloyd	OAL Systems	585-7248	oalsystems@yahoo.com	2/12	6/12
4	Bethune Morgan	NEPA	5083949	Bethune.morgan@nepa.gov.jm	8/12	10/12
5	Kevin Ellis	Rain Forest Seafoods Ltd	489-6090	Kellis@rainforestseafoods.com	-	10/12
6	Patrick Walker	Comfort Systems Ltd	960-5285		-	7/12
7	Jason Duncan	Quality Distributors	419-1079	Jasonduncan876@yahoo.com	3/12	7/12
8	Noel Brown	Caribbean Maritime University	299-3473	nbrown@cmu.edu.jm	8/12	11/12
9	Devar Brown	Tony Thwaites Wing UHWI	410-5618		7/12	8/12
10	Horace Nelson	REC Services Co. Ltd.	429-7994	Horacen@msn.com	8/12	10/12
11	Lance Malcolm	T&T Auto Cooler Ltd	844-8339	Lancetmalcolm724@gmail.com	3/12	6/12
12	Richard DaCosta	Island Grill	893-8905	rdacosta@islandgrill.com	3/12	8/12
13	Shannon Douse	NEPA	754-7540		4/12	11/12

14	Peter Williams	Spanish Court Hotel	838-6058	pwilliams@spanishcourthotel.com	5/12	7/12
15	Tamara Elliott	Comfort Systems Ltd	880-2006	tamaraelliott@comfortsystem.com	5/12	9/12
16	Richard Salmon	Geddes Refrigeration Ltd	331-5007	rsalmon@grlja.com	8/12	10/12
17	Julian Burey	Geddes Refrigeration Ltd	322-7414	jburey@grlja.com	2/12	9/12
18	Derick Goulbourne	UTECH	341-8042	Dmag85@hotmail.com	9/12	10/12
19	Chadrick Clarke	NEPA	754-7540	Chadrick.clarke@nepa.gov.ja	7/12	10/12
20	Michael Heron	Arel Ltd	999-3831	mheron@arelltd.com	4/12	7/12
21	Gregory McGregor	Island Grill	553-0470	gmcgregor@islandgrill.com	5/12	8/12

THE NATIONAL ENVIRONMENT AND PLANNING AGENCY
Capacity Building Workshop for Senior Managers
In the Refrigeration and Air-Conditioning Sector

Venue: Red Meeting Room - 10 Caledonia avenue

Date: August 17, 2020

REGISTRATION FORM

#	NAME	ORGANIZATION	CONTACT INFORMATION		
			TELEPHONE	E-MAIL	TIME
1.	Richard DaCosta	Island Grill	876-893-8905	RDaCosta@islandgrill.com	8:58 AM
2.	Gabry McGowan	ISLAND GRILL	876-553-0470	GMcGowan@islandgrill.com	8:43 AM
3.	Richard Salmon	GEDDES REFRIGERATION	876 321 5007	rsalmon@gr/ja.com	8:59 AM
4.	PETER WILLIAMS	SPANISH COURT HOTEL	876-838-6058	pwilliams@spanishcourthotel.com	9 AM
5.	Tanara Ellis	comfort systems Ltd	876-980-8006	tanaraellis@comfortsystems.com	9:05 AM
6.	PATRICK WALKER	✓	960-5785	patrickwalker@comfortsystems.com	
7.	Julian Bury	Geddes Refrigeration (JA)	322 7414	jbury@gr/ja.com	9:10 AM
8.	Derick Goussouans	UTECU	341 8000	dmag85@hotmail.com	
9.	MICHAEL HERON	AREL LTD	876-999-3831	mheron@arel.ltd.com	9:25 AM
*10.	Norbert Wildman	Appliance Traders Limited	876-342-7184	nswildman@attijamaica.com	9:50 AM



THE NATIONAL ENVIRONMENT AND PLANNING AGENCY
 Capacity Building Workshop for Senior Managers
 In the Refrigeration and Air-Conditioning Sector

Venue: Red Meeting Room - 10 Caledonia avenue

Date: August 17, 2020

	NAME	ORGANISATION	TELEPHONE	CONTACT INFORMATION EMAIL	TIME
11.	C KEVIN ELUS	RAINFOREST SEAFOODS LTD	(876) 489-6090	KEVUS@RAINFORESTSEAFOODS.COM	
12.	✓ NOEL BROWN	CMU	(876) 2993473	nbrown@cmu.edu.jm	
13.	✓ HORACE NELSON	REC	429-7994	HORACEN@MISN.COJ	
14.	✓ LANCE MALCOLM	T&T AUTO	244-8359	LANCEMALCOLM724@GMAIL.COM	
15.					
16.					
17.					
18.					
19.					
20.					



THE NATIONAL ENVIRONMENT AND PLANNING AGENCY
 Capacity Building Workshop for Senior Managers
 In the Refrigeration and Air-Conditioning Sector

Venue: Red Meeting Room - 10 Caledonia avenue

Date: August 24, 2020

REGISTRATION FORM

#	NAME	ORGANIZATION	CONTACT INFORMATION		TIME
			TELEPHONE	E-MAIL	
1.	Shannon Douse	NEPA / Pollution Prevention Branch	876-754-7540 ext. 3254	Shannon.Douse@nepa.gov.jm	9:48
2.	Chadwick Clark	PPB / NEPA	"	chadwick.clark@nepa.gov.jm	9:48
3.	Bethune Morgan	PPB / NEPA	(876) 508-3949 Ext. 3257	bethune.morgan@nepa.gov.jm	
4.					
5.		AFTERNOON SESSION			
6.	Devin Brown	TTW	410 5618	d.brown@ttwing.com	
7.	DAVID BARRETT	ENBAR CONSULTING	876 3429996	dbarrett2@gmail.com	
8.	Orville Lloyd	DAL SYSTEMS	876 585 7248	oalsystems@yahoo.com	
9.	Andrew Wright	Redstripe	876 55 1388	Andrew.Wright@heinken.com	
10.	Jason Duncan	Quality Distributors	876-49-1079	Jasonduncan876@yahoo.com	



Appendix 3:

WORKSHOPS EVALUATION SURVEY



Empowered lives.
Resilient nations.



National Environment
and Planning Agency

EVALUATION

Capacity Building of RAC Industry Senior Managers on alternatives to HCFCs

We kindly ask you to answer the following questions with the purpose of helping us to improve future training programmes

Please evaluate by ticking one of the responses

Please send to: earle.wilson@utech.edu.jm or vivian.blake@gmail.com

1) How relevant was the information presented to your work?

A.(not relevant) **B.**(relevant) **C.**(very relevant)

2) What area was most relevant?

A.(Environmental Issues & Refrigerants) **B.**(Global Issues & Refrigerants)
C.(Refrigerant Analyzer) **D.**(none)

3) What area was least relevant?

A.(Environmental Issues & Refrigerants) **B.**(Global Issues & Refrigerants)
C.(Refrigerant Analyzer) **D.**(none)

4) What area would you want further training in?

- A.(Environmental Issues & Refrigerants) B.(Global Issues & Refrigerants)
C.(Refrigerant Analyzer) D.(none)

5) Were you satisfied with the arrangements, including meals, of the workshop?

- A.(not satisfied) B.(satisfied) C.(very satisfied)

6) Was it easy to understand the presenters?

- A.(not easy) B.(easy) C.(very easy)

7) Were the demonstration with the equipment helpful?

- A.(not helpful) B.(helpful) C. (very helpful)

8) Did you feel free to ask any question at any time?

- A.(not free) B.(free) C. (very free)

9) Were the answers to your questions helpful?

- A.(not helpful) B.(helpful) C.(very helpful)

10) Overall, how do you rate this workshop

- A. (bad) B.(fair) C.(good) D.(very good) E.(excellent)

Question	A	B	C	D	E	(No Response)
A1)	0	6	12			3
A2)	5	10	3	0		3
A3)	0	0	0	18		3
A4)	5	9	2	2		3
A5)	1	5	12			3
A6)	0	3	15			3
A7)	0	4	14			3
A8)	0	4	14			3
A9)	0	5	13			3
A10)	0	0	2	10	6	3

Appendix 4: Information for Pamphlets New and Emerging Refrigerants For Specific Application

Safety Grouping of Refrigerants (ASHRAE Std. 34)

* A2L and B2L are lower flammability refrigerants with a maximum burning velocity of ≤ 10 cm/s		
	Lower toxicity	Higher toxicity
No flame propagation	A1	B1
Lower flammability	A2	B2
	A2L*	B2L*
Higher flammability	A3	B3

- The capital letter designates a toxicity class based on allowable exposure
- The numeral denotes flammability

Commercial refrigeration (over 50 ton chiller systems)

Commercial: Centralised systems

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R134a, R404A, R407A
	R717 (ammonia)	-	-	B2L	R134a, R404A, R407A
	R744 (CO ₂)	1	-	A1	R134a, R404A, R407A
HFC-HFO blends	R448A	1387	R32/125/1234yf/1234ze(E)/134a	A1	R404A
	R449A	1397	R32/125/1234yf/134a	A1	R404A

Commercial: Condensing units

* For low temperature applications					
	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R134a, R404A, R407A
	R744 (CO ₂)	1	-	A1	R134a, R404A, R407A
	R717 (ammonia)	-	-	B2L	R134a, R404A, R407A
HFC-HFO blends	R448A	1387	R32/125/1234yf/1234ze(E)/134a	A1	R404A
	R449A	1397	R32/125/1234yf/134a	A1	R404A
	R452A*	2140	R32/125/1234yf	A1	R404A
	R454C	148	R32/1234yf	A2L	R404A
	R513A	631	R1234yf/134a	A1	R134a

Industrial refrigeration (over 800 tons)

Industrial refrigeration

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R134a, R404A, R407A
	R717 (ammonia)	-	-	B2L	R134a, R404A, R407A
	R744 (CO ₂)	1	-	A1	R134a, R404A, R407A
	R1270 (propene)	2	-	A3	R134a, R404A, R407A
HFC-HFO blends	R449A	1397	R32/125/1234yf/134a	A1	R404A
	R450A	605	R1234ze(E)/134a	A1	R134a
	R513A	631	R1234yf/134a	A1	R134a
HFOs	R1233zd	4,5	-	A1	R134a, R404A
	R1234ze	7	-	A2L	R134a, R404A

Stationary air conditioning

Stationary: Moveable room AC:

(Devices that are hermetically sealed and can be moved between rooms by the user. Mostly used in private households.)

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R407A, R410A
HFCs	R32	675	-	A2L	R407A, R410A

Stationary: Single split AC:

(System that consists of one outdoor and one indoor unit linked by refrigerant piping, needing installation at the site of storage. Predominantly used in private households.)

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R407A, R410A
HFCs	R32	675	-	A2L	R407A, R410A

Stationary: Multi split AC/VRF:

(System that consists of one outdoor unit and multiple indoor units. Further developed systems enable a variable refrigerant flow (VRF) towards every indoor unit. Used in commercial facilities.)

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R407A, R410A
HFOs	R1234yf	4	-	A2L	R407A, R410A
	R1234ze	7	-	A2L	R407A, R410A
HFCs	R32	675	-	A2L	R407A, R410A

Stationary: Chiller:

(System in which the refrigerant cools down a liquid (normally water) that is then circulated to cool air in commercial or industrial facilities.)

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R134a, R407A, R410A
	R717 (ammonia)	-	-	2BL	R134a, R407A, R410A
	R718(H ₂ O)	-	-	A1	R134a, R407A, R410A
	R744 (CO ₂)	1	-	A1	R134a, R407A, R410A
	R1270 (propene)	2	-	A3	R134a, R404A, R407A
HFC-HFO blends	R452B	698	R32/125/1234yf	A2L	R410A
	R454B	466	R32/1234yf	A2L	R410A
	R455A	148	R32/1234yf/CO ₂	A2L	R404A
	R513A	631	R1234yf/134a	A1	R134a
HFOs	R1233zd	4,5	-	A1	R134a, R410A
	R1234ze	7	-	A2L	R134a, R407A, R410A
HFCs	R32	675	-	A2L	R134a, R407A, R410A

APPENDIX 5:

List of key reference documents

1. W. Goetzler, T. Sutherland, M. Rassi, J. Burgos. (2014). *Research & Development Roadmap for Next-Generation Low Global Warming Potential Refrigerants*.
<https://www.energy.gov/sites/prod/files/2014/12/f19/Refrigerants%20Roadmap%20Final%20Report%202014.pdf>
2. Danfoss: *Refrigerant options now and in the future*. 2018
<https://www.danfoss.com/media/7174/low-gwp-whitepaper.pdf>
3. European Union. Energy, Climate Change, Environment. *Climate-friendly alternatives to HCFCs*. 2020
https://ec.europa.eu/clima/policies/f-gas/alternatives_en
4. Joanna R. Turpin: *BNP Media*. 2020
<https://www.achrnews.com/articles/143548-r-454b-emerges-as-a-replacement-for-r-410a>
5. Chuck Booten, Scott Nicholson, Margaret Mann. *Refrigerants: Market Trends and Supply Chain Assessment*. National Renewable Energy Laboratory. 2020
<https://www.nrel.gov/docs/fy20osti/70207.pdf>
6. Rajan Rajendran. *How the global HFC phase-down is impacting commercial refrigeration*. System Innovation Center and Sustainability. Emerson E360 Outlook Volume 3 Number 2.
<https://climate.emerson.com/documents/v3-n2-feature-%E2%80%93-navigating-new-refrigerant-landscape-es-mx-3703356.pdf>
7. Carrier Engineering Newsletter. *New Refrigerants Impact Standards and Codes*. Volume 7, Issue 1. 2019
https://www.sharedocs.com/hvac/docs/1001/Public/08/ENG_NEWS_7_1.pdf
8. VERTIV. *Refrigerants of the Future: Their Impact on Next Generation Data Centers*
https://www.vertiv.com/globalassets/documents/white-papers/vertiv-refrigerants_of_the_future-wp-uk-low-rev.1-09.2018_246049_0.pdf
9. Daikin. *Policy and Comprehensive Actions on the Environmental Impact of Refrigerants*. 2020
https://www.daikin.com/csr/information/influence/daikin_policy-en.pdf