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Project Document - Zimbabwe

Project Title: Conversion from HFC-134a to Isobutane in the manufacture of domestic refrigerators at Capri

ATLAS Award ID: 00118906 Project ID: 00115360

Implementing Partner: Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement, Climate Change Department, Ozone Unit

Start Date: 1st of May 2019 **End Date:** 31st of May 2021 **LPAC Meeting date:** 6 May 2019

Brief Description

The objective of the project is to eliminate the use of the Ozone Depleting Substance HFC-134a in the domestic manufacturing of refrigerators and freezers in Zimbabwe by the adoption of Isobutane (HC-600a) as refrigerant. HC-600a is non-ODS, low-GWP alternative to HFC-134a and adoption of HC-600a in Zimbabwe will contribute to reducing the environmental impact of refrigeration and freezer production on global warming both in terms of the manufacturing process and the operating life of the appliances.

The total HFC refrigerant consumption in Zimbabwe in 2017 was estimated to be 190 MT, of this, it is estimated that 90% or around 171 MT was consumed, as refrigerant. The refrigerant and freezer producer Capri is one of the largest current consumers of HFC-134a in the manufacturing of domestic refrigerators and chest freezers. This project aims to phase out the use of HFC-134a in the manufacture of domestic refrigerators and freezers by the adoption of HC-600a, isobutane, as a refrigerant, at Capri; Harare, Zimbabwe. The project will modify the two existing lines, one each for refrigerators and freezers. This will require a new refrigerant storage facility and the implementation of various modifications to the production lines to make them suitable for the use of HC-600a. This project would result in annual emission reduction of about 14.5 MT of HFC-134a.

CPD outcome: Outcome 3: Vulnerable Communities are equipped to cope with climate change and build resilience for household and food and nutrition security

Result area 2: Accelerate structural transformations for sustainable development.

Output 2.1.1: Low emission and climate resilient objectives addressed in national sub-national and sectoral development plans and policies to promote economic diversification and green growth.

SDG 13: Take urgent action to combat climate change and its impacts

Total resources required:		**US$ 726,954**
Total resources allocated:		**US$ 726,954**
	Capri	US$ 300,000
	Multilateral fund incl. Government of France contribution	US $ 426,954
Unfunded:		0

DCH

Agreed by:

Government of Zimbabwe	UNDP	National Coordinating Agency
Permanent Secretary Ministry of Finance and Economic Development	**Resident Representative** UNDP Zimbabwe	**Permanent Secretary** Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement
Date:	Date: 16-10-2019	Date: 26-7-19

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UNITED NATIONS DEVELOPMENT PROGRAMME
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MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL
PROJECT COVER SHEET

Country	ZIMBABWE
Implementing Agency	UNDP
Project Title:	Conversion from HFC-134a to Isobutane in the manufacture of domestic refrigerators at Capri. (SME Harare)
NATIONAL COORDINATING AGENCY	National Ozone Technical Unit, Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement, Government of Zimbabwe

Latest Reported Consumption Data For HFCs Addressed In The Project	**2017**
Annex F: Controlled substances	
Registered Consumption of HFC-134a in Zimbabwe in 2015	-
Consumption of HFC-134a reported by company (2017) (MT)	14.5MT

PROJECT DATA

Sector	Refrigeration	
Sub Sector	Manufacturing of Domestic Refrigerators	
Project duration:	24 months	
Project Costs		
	Increment Capital Cost	**378,088**
	Contingencies	48,866
	Incremental Operating Cost[1]	-
	Total	**426,954**
	UNDP	326,954
	Government of France (bilateral to be managed by UNDP)	100,000
	Local ownership	100% (Art. 5)
	Requested grant	**426,954**
	Implementing Agency Support Cost (7%) for UNDP	22,887
	Implementing Agency Support Cost (13%) for the Government of France	13,000
	Total Project Cost to Multilateral Fund	**462,841**

** Note: Incremental operating costs will be funded by Capri.*

Prepared by: UNDP (in Consultation with the National Ozone Unit from the Ministry of Environment of Zimbabwe and Capri Zimbabwe) Date: April 2018. Revised: March 2019 (with MLF approval)

[1] Offset by Capri's US$ 300,000 co-finance support

I. Development Challenge

Zimbabwe is a signatory to the Montreal Protocol on Substances that deplete the Ozone Layer and is in the process of ratifying the Kigali Amendments with the aim to step up country efforts to reduce Ozone Depleting Substances.

In order to effectively support the country's industry to transition from Ozone Depleting Substances, the objective of the project is to eliminate the use of HFC-134a in the manufacture of Domestic refrigerators and freezers in Zimbabwe. The project targets the main manufacturer of refrigerators and freezers in Zimbabwe, Capri, to support the adoption of Isobutane (HC-600a) as refrigerant. HC-600a is non-ODS, low-GWP alternative to HFC-134a and provides a long term solution for the manufacturing company.

This project contributes to reducing the environmental impact of Capri's product on global warming both in terms of the manufacturing process and the operating life of the appliances.

1.1. SECTOR BACKGROUND

The use of R-600a in domestic refrigeration is slowly gaining momentum in Zimbabwe, most imported domestic fridges now are charged with R-600a. The country is promoting the use of Hydrocarbon. The main challenges relating to the use of R-600a in Zimbabwe will be the flammability and availability of good quality refrigerant grade material. Technicians will be trained and certified on knowledge and skills including the safe use and handling of flammable refrigerants, as part of the ongoing HPMP activities. The country has intensified training and awareness programmes and wholesalers and distributors are being trained on storage and handling as well as making sure that the refrigerant is sold to trained technicians only. The technician certification programme being implemented under the HPMP is due to be approved and rolled out imminently. Capri is one of the largest current consumers of R134A in the manufacturing of domestic refrigerators and chest freezers.

The advantages of using R-600a are reduced charge volume with the potential to makes it very economical subject to suitable supply chain and the potential for improved energy efficiency subject to the appropriate design considerations. With appropriate refrigerator designs, it should be possible to achieve 10-15% energy efficiency improvements; however that aspect is outside the scope of this project.

Ammonia (absorption) domestic refrigeration is also used in Zimbabwe, generally in remote areas that are not connected to the National Electricity grid. Suppliers of R-717 fridges have recently established distribution channels from imports to the end users in rural areas. This has seen an upsurge of absorption domestic fridges. However, there is need for extensive training as very few technicians are familiar with the technology though it is ozone and climate friendly.

The total HFC refrigerant consumption in Zimbabwe in 2017 is estimated to be 190 MT, of this, it is estimated that 90% or around 171 MT was consumed, as refrigerant.

Until recently manufacturing of domestic refrigerators and freezers in Zimbabwe was dominated by two companies, Imperial and Capri. At the time of preparation of this project, it is understood that the production of domestic refrigerators and Freezers at Imperial is negligible and Capri is effectively the sole producer. The total national production in 2017 was 97,000 units.

Table 1. Zimbabwe market of domestic refrigerators (in units).

Domestic Refrigeration	2013	2014	2015	2016	2017
Import	11,000	13,000	14,000	12,000	11,000
Export	0	6,000	5,000	4,000	21,000
Local production	65,000	78,000	78,000	91,000	97,000
Total consumption	**76,000**	**91,000**	**92,000**	**103,000**	**108,000**

Some HC-600a has been identified in limited applications in Zimbabwe, primarily in imported bottle coolers. Whilst penetration is currently limited, it is expected to increase and sector is gearing up for an increase in the use of flammable refrigerants.

Registries of import permits indicate that in 2016 all domestic refrigerators and freezers imported into Zimbabwe used HC-600a as refrigerant. Whilst the government has attempted to support the local manufacturing of refrigerators, by applying significant duty on imported units, it is not clear if this mechanism is sustainable given the competitive market, Capri is therefore keen to adopt the latest technology and remain competitive.

The project is considered a priority by the government as Capri is effectively the only remaining national producer of domestic refrigerators and freezers.

1.2 COMPANY BACKGROUND

Capri is part of the Innscor Africa group and is 100% Zimbabwean owned. It started production of refrigerator and chest freezers under the brand "Atlantic" in 1966 which was later rebranded Capri. In 1986 Capri was listed under the name "Capri Group limited" on the Zimbabwe stock exchange and in 1998 Innscor Africa Ltd reverse listed onto the stock exchange through the already listed "Capri Group Limited".

Capri currently has 300 employees and manufactured a range of two-door auto-defrost refrigerators with capacities 222-336 litre and a range of chest freezers with capacities 210-530 litre. Within the range of refrigerators, they offer a number "Enduracool" models with extra thick wall cavity designed to maintain freezer temperatures for up to 36 hours in the event of power outages, which are relatively frequent in Zimbabwe.

The company has two production lines one for refrigerators and one for freezers, located at its site in Harare. It received MLF assistance in 2011, through the HPMP for the conversion of the foaming equipment for the refrigerator line. No assistance was provided for the freezer line as it consumes HFCs.

Capri has a long standing technical capability and is responsible for the design and technical standards of its own refrigerator models. A previous agreement with Defy South Africa for the collaboration of technical design of freezers has now expired and Capri takes responsibility for its own freezer technology.

Table 2. Capacity of Capri Zimbabwe (units per year).

Production line	Installed capacity (Units/year)	Production				
		2013	2014	2015	2016	2017
Refrigerators	130,000	25,000	32,000	35,000	35,000	36,000
Freezers	104,000	40,000	46,000	43,000	56,000	61,000
Total	**234,000**	**65,000**	**78,000**	**78,000**	**91,000**	**97,000**

Capri currently exports refrigerators and freezers to Zambia and the conversion to HC-600a will allow them the company to export to more neighbouring countries including South Africa, and will allow Capri to Scale up supply in the region, where there is a growing demand for low GWP technology.

Year	Units Exported
2014	5,000
2015	4,000
2016	21,000

Currently, Capri refrigerators use HFC-134a. In 2017, Capri used 14.5 MT of HFC- 134a for the manufacture of its products. Refrigerant is supplied by a A-Gas South Africa. HFC consumption for the last 3 year is presented in table 4 below.

It should be noted that significant technical issues associated with the implementation of the conversion of the refrigerator line to cyclopentane foam blowing in conjunction with very difficult economic conditions in Zimbabwe have prevented Capri from running at full capacity in recent years. However the Innscor group is investing in order to support the business and rectify the ongoing issues with cyclopentane systems as well as supporting the conversion to HC-600a refrigerant.

Table 3 Consumption of HFC-134a at Capri Zimbabwe (metric tons per year).

Year	Production (units)	Quantity kg
2015	78,000	11,600
2016	91,000	13,600
2017	97,000	14,500
Total	**266,000**	**39,700**
Average	886,060	13,230

The average mass of foam and refrigerant used for refrigerators and freezers is shown below in table 5, along with the expected mass of foam and refrigerant after conversion. It is likely that the HC-600a refrigerant charge will be reduced further once detailed design modifications have been finalised.

Table 4 Average Mass of Foam and Refrigerant

Model Number	Description	Current Foam consumption kg/unit	Expected Foam consumption kg/unit (CP)	HFC-134a Consumption g/unit	Expected HC-600a g/unit
ALL AVE	Freezers	9.66	9.66	149	70
ALL AVE	Refrigerators	10.47	10.47	149	70

Capri has long standing supply arrangements with a number of chemical suppliers, initial discussions indicate that refrigerant grade HC-600a will be available via A-Gas South Africa. The current prices for main chemicals are shown in table 6.

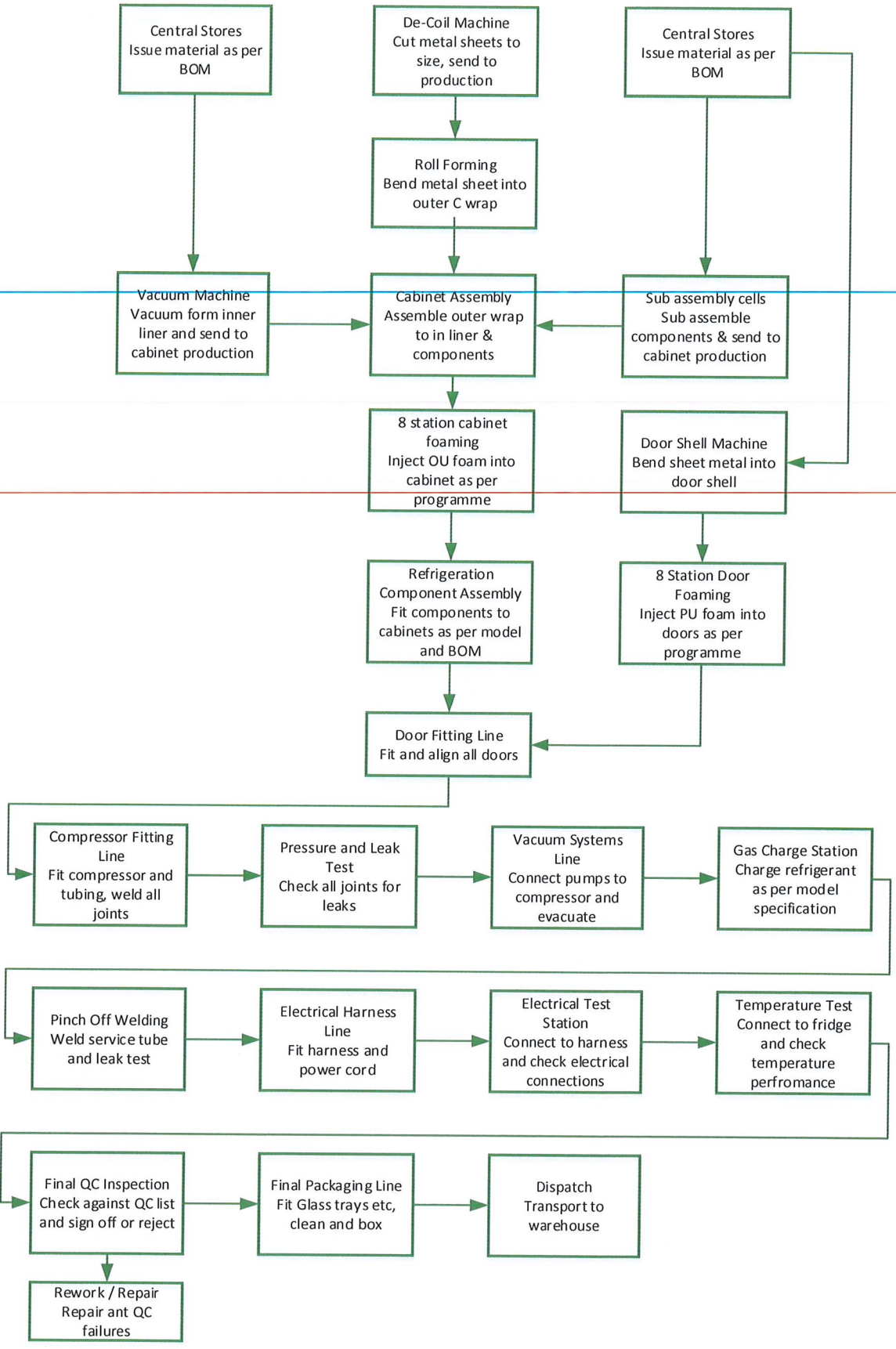
Table 5 Chemical Prices Supplied to Capri Harare

Chemical	Cost $/kg	Supplier	Availability
HFC-134a	5.82	A-Gas South Africa	Good
HC-600a	9.50	A-Gas South Africa	bulk

1.3 CURRENT PROCESS

Capri's refrigerator manufacturing facility is located in a purpose build factory on a light industrial estate in the outskirts of Harare. The production lines follow a traditional approach and logic for a domestic appliance manufacturer of this size. The company has operated from the site for more than 20 years. Due to the prevailing economic conditions and difficulties procuring components Capri has adopted a strategy of manufacturing as many components as possible in house, and has invested in range of metal forming, vacuum forming and injection moulding equipment in order to be as self-sufficient as possible. The only principle components imported are the compressors from Embraco. The process is shown diagrammatically below; photos of the production lines are included in Annex 1.

Capri Refrigerator Production Process



1.4 JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

The selection of the alternative technology considered the following requirements:

- Proven and reasonably mature technology.
- Cost effective conversion.
- Availability of the products at favourable pricing.
- Characteristics to be presented by the product (in this project-heat load simulation, preferred refrigerant charged amount, cooling performance, etc.).
- Compliance with established (local and international) standards on safety and environment.
- Energy efficiency.
- Reduced carbon footprint.

Capri Zimbabwe plans to convert all products to use Isobutane (HC-600a).

- Refrigerant should be no more expensive and potentially cheaper than HFC-134a if bulk storage is available and break bulk supply is procured, the refrigerant charge will also be lower, current design expectation is for 70% of the HFC charge.
- The refrigeration circuit is more tolerant to impurities.
- Coefficient of Performance (COP) and Energy Efficiency Ratio (EER) are generally higher than that for HFC-134a, given the appropriate circuit design.
- HC-600a is recognised as a low-GWP solution.
- Although its use in Zimbabwe is relative new, HC-600a is a proven technology, especially in developed countries and is now the standard refrigerant in the majority of new domestic refrigerators and freezers globally

The main issues associated with use of isobutane are the flammability and the need for special charging, leak testing equipment, and flame proof areas with special monitoring equipment to ensure that the permissible atmospheric levels of hydrocarbons are not exceeded.

Because the refrigerant charge is small, the acceptable leakage rate to guarantee a 15-year working life of the appliance is much lower than that for HFC-134a based equipment. The new detection equipment must be more sensitive and capable for detecting hydrocarbons rather than halogen containing molecules.

- Refrigerators must be designed with spark free electric components (Thermostat, Overload protector, lamp assembly and door switch).
- Due to higher COP and explosive resistant structure, compressor price is around 30% higher than HFC-134a system.
- It is essential to properly train the employees working in the manufacturing facility in the safe handling and storage of flammable refrigerants and in the safe operation of equipment in the production area.
- A full fire safety assessment and certificate is required before the plant can be operated.
- Field technicians and service staff must be properly trained and aware of the presence of refrigerators and freezers containing HC refrigerants
- All appliances should be clearly labelled to indicate the presence of flammable refrigerant.

II. Strategy

This project will support the introduction of HC-600a to Capri through the following steps:

- **Changes to the production lines:** The production lines require changes in equipment, suitable to work with HC-600a, and new processes to secure the safety of operations and the quality of the HC-based refrigerators.
- **Training of staff:** All production personnel shall to be trained on the operation of the new equipment, safety aspects, and concepts related to the use of HC-based refrigerants.

Overall, the theory of change is as follows: **IF** production lines are converted to HC-600a, new safety processes are put in place, new quality assurance processes are put in place, and staff are trained, **THEN** this which will lead to a reduction in the use of HFC-134a in the manufacture of domestic refrigerators and freezers at Capri in Zimbabwe, contributing to the achievement of global goals on ODS emissions reduction. The project approach is described more in detail in sections below.

2.1 PROJECT DESCRIPTION

Changing the refrigerant, HFC-134a by HC-600a, involves several modifications, both to the production process and to the end product, due mainly to its high flammability. Equipment used to charge HFC-134a cannot be used to work with HC-600a as they are required to be explosion proof. The charging and leak testing areas in the production line must also be protected by HC leak detectors and a safety system with automatic alarms and ventilation system.

The adoption of HC-600a requires major adjustment in several parts or sections of the manufacture process, such as:

- Storage and distribution of refrigerant.
- Pre-charge vacuum process.
- Refrigerant charge.
- Rearrangement of the soldering operations.
- Installation of a leak detection and safety system.
- Installation of ventilation system

As part of the project, both production lines will be converted to HC-600a and the conversion will address all areas required including, refrigerant storage and supply system, modifications to the production lines, and training and awareness of staff. The MLF investment costs are subject to the approved project's budget in line with Annex 2.

It should be noted that the use of flammable volatile substances, such as Cyclopentane and isobutene, could lead to the formation of explosive atmospheres (ATEX)2, requiring that the company establishes different risk profile zone according to international regulations and that all equipment located within that zone must comply with the explosion proof and spark free

[2] The common terminology is ATEX from the French title of the 94/9/EC directive: *Appareils destinés à être utilizes en ATmosphères EXplosibles*.

certifications, such as Directive 2014/34/EU[3]. So, for gases, vapours and mists, the following zone classifications are established:

- Zone 0: A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is present continuously or for long periods or frequently.
- Zone 1: A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally.
- Zone 2: A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

All project components and equipment must comply with international standards and regulations (i.e. NFPA58).

2.2 STORAGE AND FEEDING OF REFRIGERANT

This component includes: a) Refrigerant delivery, b) Storage, c) Refrigerant feed system d) Safety system and e) Certification of installation and operation.

a) Refrigerant Offloading System

Refrigerant will be delivered in isotanks and must then be transferred to the site storage tank. A pumping system to download the refrigerant is required; this system should have control and safety instruments. Transfer pumps and related equipment must be explosion proof. The system should have a liquid download connection and gas balance lines are required. Leak detectors are required, connected to the general safety system and fire protection must be installed.

b) Refrigerant storage

HC-600a must be store above ground and must be equipped with HC detectors, connections, controls and valves in line with current international regulations. Protection on the perimeter of the tanks is required, items such as fire resistance walls, nets and security bollards must be included. Civil and Mechanical works related to the storage tank involves the construction of pump and transfer rooms, retention tank and the foundation for the construction. Additionally, the area will have an automated water sprinkler system and smoke detectors. The tank and related equipment must be electrically grounded.

c) Refrigerant supply System.

Once stocked, refrigerant has to be sent to the production lines trough pumps and pipes. Pipes have to be of stainless steel with thermal insulation, clearly indicating that HC-600a is in the pipeline. Once installed, a leakage test must be carried out as well as appropriate testing of the pipework and all welded joints.

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[3] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0034&from=EN, DIRECTIVE 2014/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres.

d) Safety system

The storage and transfer areas must be equipped with a safety system including leak detectors, and firefighting equipment, shut off valves and flow and pressure sensors. The safety system of this zone will be connected to the general safety system of the plant.

e) Certification of installation and operation

The correct installation and safety operation of all equipment has to be certified. X-rays and pressure test have to be conducted.

2.3 PRODUCTION LINE MODIFICATIONS

For the introduction of HC-600a, the production lines require changes in equipment, as installed equipment for HFC-134a is not suitable to work with HC-600a, and new processes, such as filling with Helium to identify leaks before refrigerant is charge, to secure the safety operation and quality of the HC-based refrigerators.

Modification to the production lines can be separated in six sections: a) Pre-charge leak detection, b) refrigerant charge, c) post-charge leak detection, d) Functional repair zone, e) related Civil and Mechanical works, and f) safety system.

a) Pre-charge leak detection

Once the refrigeration system is installed in the refrigerator and before the HC-600a is charged, vacuum of the system will be conducted and helium will be injected to determine if the system is leakage-free. After the test, helium is recovered to be reused in the process. This step was not part of the production with HFC-134a.

b) Refrigerant charge

Capri has 2 charging stations, 1 per line. The current charging stations for HFC-134a are not suitable to work with HC-600a. New charging stations will comply with international safety standard and will be located in a secure zone, classified as Zone 2, where all equipment must be ATEX certified.

Once the charging of the HC-600a in the refrigerator has concluded, pipelines must be sealed. The process is currently performed with natural gas and oxygen. In refrigerators containing hydrocarbons, sealing with equipment that has a source of ignition is not allowed, the circuits must therefore be sealed using ultrasonic welding equipment.

c) Post-charge leak detection

After the refrigerant is charged into the refrigerator, a leak test is performed in the low and high-pressure sides of the refrigerator therefore two (2) leak detectors are required per production line. Due to the small charge of refrigerant, the leak detector to be used required higher sensitivity to detect very small leaks (up to 0.05 g/year).

d) Functional repair zone

When a refrigerator presents leakage of refrigerant, it is sent to the functional repair zone where refrigerant is extracted and sent to the exhaust system, then the failure is corrected and the refrigerator is sent to the helium leak test station to start all over the process. This area is also classified as Zone 2 and requires a safety system and all equipment certified as ATEX equipment.

e) Civil and Mechanical works

The Civil and Mechanical works will involve the installation of new equipment, new connections (such as air, HC-600a, helium, electricity), the electric grounding of all structures and equipment within the area, rearrangement of the conveyer system, construction of new structures for the ventilation system.

f) Safety system

Each production line must have a safety system to protect the areas where HC-600a is being used, this shall include leak detectors, shut off valves, and pressure sensors, control panel, and emergency stop buttons. The safety system of each line will be connected to the general safety system of the plant.

Additionally, there is required a ventilation system that secure a constant flow of air, with different levels of extraction depending on the existing conditions; HC's leak detectors will be installed in the area surrounding the charging and welding stations, also in the functional repair zone. Common practice accepted safety concepts establish that normal operation conditions are those were HC concentration is below the 15% of its Low Explosion Level (LEL), under this conditions fans of the extraction system work at 50% of their nominal speed; if there is a leakage and concentration of HC reaches 15% of its LEL, a warning is sent to the central control panel, increasing fan's speed to 100%. If concentration of HC reaches 35% of its LEL, energy supply to the equipment located within the zone is suspended, supply of HC-600a is cut off and a general evaluation alarm is activated. The safety system informs the place where the alarm was generated.

2.4 GENERAL ACTIVITIES

In additional to the main technical changes required for the production conversion there are a number of supporting activities that must be carried out.

a) Changes in electrical controls.

The electrical controls of the new HC-based fridges require changes to ensure their safety operation, this involve modification to both the circuit board and the equipment needed for testing this circuit board.

b) Installation and start-up.

Once all equipment is delivered to the plant, old equipment used for HFC-134a has to be removed and new equipment installed and tested. Technicians from the selected supplier, with support of the engineering department of Capri, will be involved in the installation and start-up process.

c) Trials and test.

A number of trials will be required on all new models to assess operation, identify possible failures and assure that new products comply with quality and performance standards.

d) Training of personnel.

All production personnel shall be trained on the operation of the new equipment, safety aspects, and concepts related to the use of HC-based refrigerants.

e) Certification of products.

As performance and technical specification of new HC-600a-based refrigerators will differ from current models, the new models will have to be certified by a third party so that they can be put into the market and be labelled accordingly to local regulations.

f) Safety certification.

After the installation and start-up of all equipment, it is mandatory to have a plant certified by the appropriate safety body. A comprehensive safety audit will be conducted by a third party. Directives such as ATEX or local equivalent will be used.

g) Technical assistance.

Technical assistance is to be provided by international experts to ensure a smooth transition to the new replacement technology. The expert functions include overall technical supervision of conversion projects, technical coordination between equipment suppliers, recipient enterprises and the implementing/executing agency. Experts will give support to the preparation of equipment specifications and the bid evaluation from suppliers during the competitive bidding process; also, they will give technical guidance to the recipient enterprise during start-up with the new equipment or process and on the results of production and product quality trials. Technical experts are required for solving technical problems with the phase-in of the new equipment or processes and during the technical project commissioning including final technical inspection of equipment and process.

h) Other

As HC-600a will be the new refrigerant, personnel working in the production line will require a set of ATEX certified tools to avoid possible source of sparks and portable HC detectors to conduct inspections or test, both to the production line and to the refrigerators.

III. Results and Partnerships

3.1 EXPECTED RESULTS

The expected results of the project are as follows:

- By May 2021, the production lines for refrigerators and freezers have been fully converted to HC-600ª
- By end of 2020 adequate safety measures are in place and CAPRI complies with relevant international regulations and certification
- By end of 2020 new refrigerator and freezer products comply with quality and performance standards.
- By end of 2020 all production personnel are trained on the operation of the new equipment, safety aspects, and concepts related to the use of HC-based refrigerants.
- By May 2021 a GHG emission reduction of over 300 kT CO2eq has been realised due to direct and indirect emissions reduction (based on the minimum operating capacity of the plant).

3.2 ENVIRONMENTAL IMPACT

With the substitution of HFC-134a in Capri Zimbabwe by adopting HC-600a as refrigerant, with the assumption that all refrigerant will be emitted to the atmosphere when the refrigerator is disposed, the project will reduce the annual emission of 311 kT ton CO2-eq based on the expected minimum operating capacity of the plant. In addition to the direct impact, it is estimated that the energy efficiency improvement in new models will result in an indirect emissions reduction of 27 kT ton CO2-eq. See Annex 3

3.3 RISKS AND ASSUMPTIONS

The risks and assumptions for the project are as follows:

Assumptions	Risks
Policies and regulatory frameworks facilitate the phasing out of ODS, in line with the Montreal Protocol and Kigali Amendments	Although the country has taken significant steps towards addressing ODS, the ratification of the Kigali Amendments are still outstanding
Financial institutions, investors are interested in investing in green business cases. Consumers buy locally manufactured fridges.	An enabling economic environment is key to facilitate investments and sales. While the project works to facilitate improved quality of product, sufficient investments and sales cannot be guaranteed.

3.4 STAKEHOLDER ENGAGEMENT

Key national stakeholders in efforts to convert from HFC-134a to Isobutane in the manufacture of domestic refrigerators at Capri include the following:

Key stakeholder	Responsibility/Expertise
Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement	The Climate Change Management Department is responsible for coordination and implementation of international environment and climate change treaties to which the Republic of Zimbabwe is part (including UNFCCC and the Montreal Protocol). The Ozone Unit under the CCMD is responsible for management of this project on behalf of the Government of Zimbabwe.
Ministry of Industry, Commerce and Enterprise Development	Key stakeholder in Industry. Compilers of national data on emisión reduction initiatives in Industry, promotion of clean technologies.
Capri	The main national producer of refrigerators and freezers.

3.5 SUSTAINABILITY AND SCALING UP

Sustainability considerations include aligning to national development and legal frameworks (e.g. TSP, the NDC, the NCCRS, the Climate Policy, Statutory Instrument 7 of 2011(Prohibition and Control of Ozone Depleting Substances and Equipment)), capacity building and knowledge enhancement among key stakeholders. Substantive involvement of relevant authorities, institutions, private sector partners in implementing and monitoring activities will ensure buy in. The project will share lessons at national level with a purpose of scaling up or conducting ODS phase out in other sectors.

IV. Project Management

4.1 PROJECT COSTS

Incremental capital cost

The total investment cost is **US$ 563,526**, including contingencies. Details are provided in Annex 2.

This includes incremental capital costs with contingencies, and part of the Capri's co-finance support.

Incremental operational cost

Incremental operating costs are not being claimed by Capri (absorbed in the co-finance support) and are presented in the project's budget (Annex 2). The original calculation of the IOCs is provided in Annex 5 with the explanation of re-adjustments made in consultations with the MLF Secretariat.

The re-adjusted IOCs are: **US$ 163,428**.

Cost Effectiveness (CE)

CE on the total project costs is 50.13 US$/kg, and for the requested funding from the MLF is 29.45 US$/kg.

Grant request to the multilateral fund

The requested calculated grant to the Multilateral Fund is **US$ 426,954 (with bilateral support of the Government of France included in the amount of US$ 100,000)**, for incremental capital (ICCs) and operating (IOCs) cost, including contingencies embedded in ICCs, taking into account a separate Capri co-funding component of US$300,000 as a first agreed co-investment commitment to cover part of ICCs and IOCs.

V. Results Framework

Outcome indicators as stated in the Country Programme [or Global/Regional] Results and Resources Framework, including baseline and targets:

CPD outcome: Outcome 3: Vulnerable Communities are equipped to cope with climate change and build resilience for household and food and nutrition security

Applicable Output(s) from the UNDP Strategic Plan: **UNDP Strategic Plan Outcome:** Outcome 5 - Countries are able to reduce the likelihood of conflict, and lower the risk of natural disasters, including from climate change

Result area 2: Accelerate structural transformations for sustainable development.

Output 2.1.1: Low emission and climate resilient objectives addressed in national sub-national and sectoral development plans and policies to promote economic diversification and green growth.

Project title: Conversion from HFC-134a to Isobutane in the manufacture of domestic refrigerators at Capri

Atlas Project Number:

EXPECTED OUTPUTS	OUTPUT INDICATORS	DATA SOURCE	BASELINE		*TARGETS (by frequency of data collection)*			*DATA COLLECTION METHODS & RISKS*
			Value	Year	Year 2019	Year 2020	*FINAL Year 2021*	
Output 1: Elimination of the use of HFC-134a in the manufacture of Domestic refrigerators and freezers	By May 2021, the production lines for refrigerators and freezers have been fully converted to HC-600a	*Company reports, visits*	Both production lines currently use HFC-134a	2019			*Production lines for refrigerators and freezers fully converted*	Final evaluation, observation, external consultants assessment
	By end of 2020 adequate safety measures are in place and CAPRI complies with relevant international regulations and certification	*Safety guidelines and safety/incidence records, compliance documentation*	Need for additional safety measures to adopt HC-600	*2019*		*Adequate safety measures in place*		Final evaluation, external consultants assessment, assessment of certification and standards compliance documents

at Capri, Zimbabwe, by the adoption of Isobutane (HC-600a) as refrigerant.	By end of 2020 new refrigerator and freezer products comply with quality and performance standards.	*Trials and test reports*	-			*Trials and performance testing successfully conducted*		*Observation, review of trial and test reports*
	By end of 2020 all production personnel are trained on the operation of the new equipment, safety aspects, and concepts related to the use of HC-based refrigerants.	*Training reports, personnel*	Production personnel not trained on concepts related to HC-600a refrigerant, new equipment, safety aspecs	*2019*		*Training of all personnel conducted*		*Final evaluation. Review of traning reports, KII's/survey/FGD's with production personnel*
	By May 2021 a GHG emission reduction of over 300 kT CO2eq has been realised due to direct and indirect emissions reduction (based on the minimum operating capacity of the plant).	*GHG and energy data records*	(Based on 97000 units) Average daily electricity consumption 1,2 KWh; HFC-134a consumption: 14500 kg	*2019*			*GHG emission reduction targets achieved*	*Final evaluation. Review of GHG and energy data records*

VI. Monitoring And Evaluation

Monitoring Plan

Monitoring Activity	Purpose	Frequency	Expected Action	Partners (if joint)	Cost (if any)
Track results progress	Progress data against the results indicators in the RRF will be collected and analysed to assess the progress of the project in achieving the agreed outputs.	Biannually, or in the frequency required for each indicator.	Slower than expected progress will be addressed by project management.	GoZ Ozone Unit, UNDP, CAPRI	
Monitor and Manage Risk	Identify specific risks that may threaten achievement of intended results. Identify and monitor risk management actions using a risk log. This includes monitoring measures and plans that may have been required as per UNDP's Social and Environmental Standards. Audits will be conducted in accordance with UNDP's audit policy to manage financial risk.	Biannually	Risks are identified by project management and actions are taken to manage risk. The risk log is actively maintained to keep track of identified risks and actions taken.	GoZ Ozone Unit, UNDP, CAPRI	
Learn	Knowledge, good practices and lessons will be captured regularly, as well as actively sourced from other projects and partners and integrated back into the project.	At least annually	Relevant lessons are captured by the project team and used to inform management decisions.	GoZ Ozone Unit, UNDP, CAPRI	
Annual Project Quality Assurance	The quality of the project will be assessed against UNDP's quality standards to identify project strengths and weaknesses and to inform management decision making to improve the project.	Annually	Areas of strength and weakness will be reviewed by project management and used to inform decisions to improve project performance.	GoZ Ozone Unit, UNDP, CAPRI	
Review and Make Course Corrections	Internal review of data and evidence from all monitoring actions to inform decision	At least annually	Performance data, risks, lessons and quality will be discussed by	GoZ Ozone Unit, UNDP,	

	making.		the project board and used to make course corrections.	CAPRI	
Project Report	A progress report will be presented to the Project Board and key stakeholders, consisting of progress data showing the results achieved against pre-defined annual targets at the output level, the annual project quality rating summary, an updated risk long with mitigation measures, and any evaluation or review reports prepared over the period.	Annually, and at the end of the project (final report)		GoZ Ozone Unit, UNDP, CAPRI	
Project Review (Project Board)	The project's governance mechanism (i.e., project board) will hold regular project reviews to assess the performance of the project and review the Multi-Year Work Plan to ensure realistic budgeting over the life of the project. In the project's final year, the Project Board shall hold an end-of project review to capture lessons learned and discuss opportunities for scaling up and to socialize project results and lessons learned with relevant audiences.	Specify frequency (i.e., at least annually)	Any quality concerns or slower than expected progress should be discussed by the project board and management actions agreed to address the issues identified.	GoZ Ozone Unit, UNDP, CAPRI	

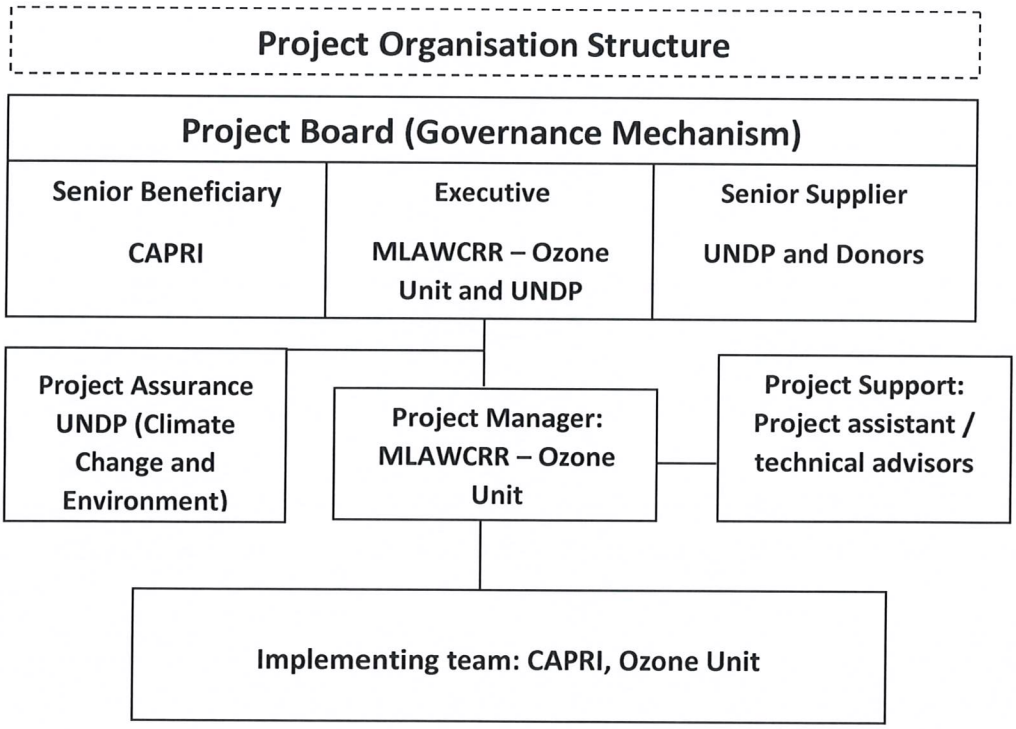
VI. Governance and Management Arrangements

6.1 PROJECT MANAGEMENT - IMPLEMENTATION ARRANGEMENT AND SCHEDULE

The project will be delivered under the UNDP National Implementation Modality (NIM) arrangement. Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement, through its Ozone Unit, under the Climate Change Department, will be the implementing Partner. UNDP will be responsible for managing the fund and for providing quality assurance. UNDP will also support CAPRI in procurement of project equipment and other services. The Ozone Project Technical Committee chaired by the Director Climate Change Department will provide oversight and strategic guidance. The committee will meet at least twice a year to consider the project workplan and reports and provide strategic guidance.

The project is expected to be completed within 24 months of funding approval.

Project audit: Audits will be conducted in accordance with UNDP's audit policy to manage financial risk.



VII. Legal Context

The project shall be the instrument referred to as Article 1 of the Standard Basic Assistance Agreement between the Government of Zimbabwe and the United Nations Development Programme signed by both parties on 20th May, 1980. The host country implementing agency for the purpose of the Standard Basic Assistance Agreement refers to the government cooperating agency described in that agreement. All references in the SBAA to "Executing Agency" shall be deemed to refer to "Implementing Partner."

This project will be implemented by Ministry of Lands, Agriculture, Water, Climate & Rural Resettlement ("Implementing Partner") in accordance with its financial regulations, rules, practices and procedures only to the extent that they do not contravene the principles of the Financial Regulations and Rules of UNDP. Where the financial governance of an Implementing Partner does not provide the required guidance to ensure best value for money, fairness, integrity, transparency, and effective international competition, the financial governance of UNDP shall apply.

The following types of revisions may be made to the Project document with the signature of UNDP Resident Representative only, provided he or she is assured that the other signatories of the programme document have no objection to the proposed changes:

- Revision or addition of any of the annexes of the programme support document;
- Revisions, which do not involve significant changes in the objectives, outputs or activities which are caused by the re-arrangement of the inputs that are already agreed to by cost increases due to inflation;
- Mandatory annual revisions, which re-phase the delivery of agreed programme inputs or increased expert or other costs due to inflation or take into account agency expenditure flexibility.

This document together with the Country Programme Action Plan (CPAP) signed by the Government and UNDP which is incorporated by reference constitute together a Project Document as referred to in the Standard Basic Assistance Agreement (SBAA) and all CPAP provisions apply to this document.

VIII. Risk Management

Government Entity (NIM)

1. Consistent with the Article III of the SBAA *[or the Supplemental Provisions to the Project Document]*, the responsibility for the safety and security of the Implementing Partner and its personnel and property, and of UNDP's property in the Implementing Partner's custody, rests with the Implementing Partner. To this end, the Implementing Partner shall:
   a) put in place an appropriate security plan and maintain the security plan, taking into account the security situation in the country where the project is being carried;

b) assume all risks and liabilities related to the Implementing Partner's security, and the full implementation of the security plan.

2. UNDP reserves the right to verify whether such a plan is in place, and to suggest modifications to the plan when necessary. Failure to maintain and implement an appropriate security plan as required hereunder shall be deemed a breach of the Implementing Partner's obligations under this Project Document.

3. The Implementing Partner agrees to undertake all reasonable efforts to ensure that no UNDP funds received pursuant to the Project Document are used to provide support to individuals or entities associated with terrorism and that the recipients of any amounts provided by UNDP hereunder do not appear on the list maintained by the Security Council Committee established pursuant to resolution 1267 (1999). The list can be accessed via http://www.un.org/sc/committees/1267/aq_sanctions_list.shtml.

4. Social and environmental sustainability will be enhanced through application of the UNDP Social and Environmental Standards (http://www.undp.org/ses) and related Accountability Mechanism (http://www.undp.org/secu-srm).

5. The Implementing Partner shall: (a) conduct project and programme-related activities in a manner consistent with the UNDP Social and Environmental Standards, (b) implement any management or mitigation plan prepared for the project or programme to comply with such standards, and (c) engage in a constructive and timely manner to address any concerns and complaints raised through the Accountability Mechanism. UNDP will seek to ensure that communities and other project stakeholders are informed of and have access to the Accountability Mechanism.

6. All signatories to the Project Document shall cooperate in good faith with any exercise to evaluate any programme or project-related commitments or compliance with the UNDP Social and Environmental Standards. This includes providing access to project sites, relevant personnel, information, and documentation.

7. The Implementing Partner will take appropriate steps to prevent misuse of funds, fraud or corruption, by its officials, consultants, responsible parties, subcontractors and sub-recipients in implementing the project or using UNDP funds. The Implementing Partner will ensure that its financial management, anti-corruption and anti-fraud policies are in place and enforced for all funding received from or through UNDP.

8. The requirements of the following documents, then in force at the time of signature of the Project Document, apply to the Implementing Partner: (a) UNDP Policy on Fraud and other Corrupt Practices and (b) UNDP Office of Audit and Investigations Investigation Guidelines. The Implementing Partner agrees to the requirements of the above documents, which are an integral part of this Project Document and are available online at www.undp.org.

9. In the event that an investigation is required, UNDP has the obligation to conduct investigations relating to any aspect of UNDP projects and programmes. The Implementing Partner shall provide its full cooperation, including making available personnel, relevant documentation, and granting access to the Implementing Partner's (and its consultants', responsible parties', subcontractors' and sub-recipients') premises, for such purposes at reasonable times and on reasonable conditions as may be required for the purpose of an investigation. Should there be a

limitation in meeting this obligation, UNDP shall consult with the Implementing Partner to find a solution.

10. The signatories to this Project Document will promptly inform one another in case of any incidence of inappropriate use of funds, or credible allegation of fraud or corruption with due confidentiality.

    Where the Implementing Partner becomes aware that a UNDP project or activity, in whole or in part, is the focus of investigation for alleged fraud/corruption, the Implementing Partner will inform the UNDP Resident Representative/Head of Office, who will promptly inform UNDP's Office of Audit and Investigations (OAI). The Implementing Partner shall provide regular updates to the head of UNDP in the country and OAI of the status of, and actions relating to, such investigation.

11. *Choose one of the three following options:*

    Option 1: UNDP shall be entitled to a refund from the Implementing Partner of any funds provided that have been used inappropriately, including through fraud or corruption, or otherwise paid other than in accordance with the terms and conditions of the Project Document. Such amount may be deducted by UNDP from any payment due to the Implementing Partner under this or any other agreement. Recovery of such amount by UNDP shall not diminish or curtail the Implementing Partner's obligations under this Project Document.

    Option 2: The Implementing Partner agrees that, where applicable, donors to UNDP (including the Government) whose funding is the source, in whole or in part, of the funds for the activities which are the subject of this Project Document, may seek recourse to the Implementing Partner for the recovery of any funds determined by UNDP to have been used inappropriately, including through fraud or corruption, or otherwise paid other than in accordance with the terms and conditions of the Project Document.

    Option 3: UNDP shall be entitled to a refund from the Implementing Partner of any funds provided that have been used inappropriately, including through fraud or corruption, or otherwise paid other than in accordance with the terms and conditions of the Project Document. Such amount may be deducted by UNDP from any payment due to the Implementing Partner under this or any other agreement.

    Where such funds have not been refunded to UNDP, the Implementing Partner agrees that donors to UNDP (including the Government) whose funding is the source, in whole or in part, of the funds for the activities under this Project Document, may seek recourse to the Implementing Partner for the recovery of any funds determined by UNDP to have been used inappropriately, including through fraud or corruption, or otherwise paid other than in accordance with the terms and conditions of the Project Document.

    Note: The term "Project Document" as used in this clause shall be deemed to include any relevant subsidiary agreement further to the Project Document, including those with responsible parties, subcontractors and sub-recipients.

12. Each contract issued by the Implementing Partner in connection with this Project Document shall include a provision representing that no fees, gratuities, rebates, gifts, commissions or other payments, other than those shown in the proposal, have been given, received, or promised in connection with the selection process or in contract execution, and that the recipient of funds from the Implementing Partner shall cooperate with any and all investigations and post-payment audits.

13. Should UNDP refer to the relevant national authorities for appropriate legal action any alleged wrongdoing relating to the project, the Government will ensure that the relevant national authorities shall actively investigate the same and take appropriate legal action against all individuals found to have participated in the wrongdoing, recover and return any recovered funds to UNDP.

14. The Implementing Partner shall ensure that all of its obligations set forth under this section entitled "Risk Management" are passed on to each responsible party, subcontractor and sub-recipient and that all the clauses under this section entitled "Risk Management Standard Clauses" are included, *mutatis mutandis*, in all sub-contracts or sub-agreements entered into further to this Project Document.

ANNEXES

1. **Photos of manufacturing operations**
2. **Project budget**
3. **Emission reduction**
4. **Milestones for Project monitoring**
5. **Incremental operational costs**
6. **Project Quality Assurance Report** – attached seperately
7. **Social and Environmental Screening Template** – attached seperately
8. **Risk Analysis** – attached seperately
9. **Capacity Assessment:** Results of capacity assessments of Implementing Partner (including HACT Micro Assessment) – attached seperately
10. **Project Board Terms of Reference and TORs of key management positions** – attached seperately

ANNEX 2. PROJECT'S BUDGET

Description	Budget
Refrigerant storage, distribution and safety system	58,000
Helium leak-detection system including helium storage and recovery	90,000
Refrigerant charging system including pumps and accessories	110,000
Leak detection for R600a in refrigerant charging area	26,000
Ultrasonic welding machine	50,000
Gas evacuation system for repair area	4,000
Safety and ventilation	100,000
Contingency on equipment	48,866
Sub-total for hardware	**486,866**
Installation, inspection visit, spare parts and start-up	30,660
Test and trial	20,000
Redesign, safety certificate, technical assistance and training	26,000
Sub-total for start-up, safety	**76,660**
Sub-total for ICCs	**563,526**
Sub-total for IOCs	**163,428**
Total for ICCs and IOCs	**726,954**
Capri's co-finance (against ICCs and IOCs)	**300,000**
Total	**426,954**

Note: The co-finance has resulted in the adjustment of the MLF/Government of France project budget to US$ 426,954, of which the bilateral contribution from the Government of France constitutes US$ 100,000 and will be transferred to UNDP in 2019 based on an MoU.

ANNEX 4: MILESTONES FOR PROJECT MONITORING

(in months, measured from project approval)

TASK	MONTH
(a) Project document submitted to beneficiary	1
(b) Project document signatura	3
(c) Conversion design for Capri prepared	4
(d) Bids formulated and requested in terms of ITB	5
(e) Contracts Awarded	7
(f) Equipment Delivered/Installed	17
(g) Training Testing and Trial Runs	19
(h) Commissioning / Project Completion	21
(i) HOP signature	23
(j) Project Completion Report	24

parts are taken to be possible refrigerant sources through leaks. This includes evaporators, condensers, door heaters, pipes and the compressor.

Incremental cost	Refrigerator Average		Freezer Average	
	Incremental Cost per unit	Annual Cost for production	Incremental Cost per unit	Annual Cost for production
Compressor	1.00	35,333	1.50	80,000
Electrical safety fan, lights etc.	2.20	77,733	2.50	133,333
Efficiency modifications	0.50	17,667	0.50	26,667
TOTAL	**3.70**	**130,733**	**4.50**	**240,000**

Summary of IOC

Line	Refrigerators	Freezers	Total
Refrigerant	-6,472	130,733	124,261
Components	-9,770	240,000	230,230
Total for 1 year	**-16,242**	**370,733**	**354,491**

Based on these original calculations, the Incremental Operating Costs were re-adjusted to the level of **US$ 163,428** in line with consultation with the MLF Secretariat in October 2018.