Mitigation of climate change from the aspect of controlling F-gases in the field of cooling technology

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Abstract. The main objective is to identify, analyze and deliver data on F-gases in Bosnia and Herzegovina and identify potential mitigation measures. Bosnia and Herzegovina became a member of the United Nations Framework Convention on Climate Change (UNFCCC) on December 6, 2000. In its status as non-Annex I country within the UNFCCC, Bosnia and Herzegovina is obliged to undertake the following reporting activities, such as: to calculate annual emissions of greenhouse gases using a defined methodology and reporting to the Conference of the Parties (COP), introduce and implement measures to mitigate the effects of climate change by regulating anthropogenic emissions and adaptation measures to climate change. Also cooperate in the development and transfer of technology, methods and processes that lead to limitation, reduction and stabilization of greenhouse gas emissions, include an impact assessment of climate change and appropriate economic development strategies and policies aimed at minimizing the negative impacts of climate change on the economy, the environment and the health of the population; conduct systematic observation and research, exchange data and exchange information on climate and climate change in order to improve scientific discoveries on the causes and consequences of climate change.

This project not only supports the country of Bosnia and Herzegovina in fulfilling the above obligations as a signatory to the UNFCCC, but will also serve as an important strategic document for sustainable development. Also, this project promotes relations between entities and business sectors, establishing links between the environment and other sectors. The data on the emission of F-gases in Bosnia and Herzegovina, including sources of these gases, are provided. In this paper, potentially intrusive measures are suggested. Ozone is a gas located in the earth's atmosphere in a layer of 15 to 35 km above the Earth and has a special significance for the planets and the entire life on it. It is very important his role for the protection of life on Earth, and the disrupted occurrences of ozone flows through the atmosphere can have harmful effects on the health of man and the environment as a whole. The amount of ozone in the tropospheric (in the first lower layer above the Earth) and the stratospheric (upper-upper layer) was in the past in a natural balance. Uncontrolled human activity, in particular the development of the refrigeration industry, and the accelerated increase in the emissions of individual industrial gases, there was an increase in ozone levels in the tropospheric layer and in the stratospheric reduction. Concentration of ozone in the stratosphere and troposphere is limited by the balance between the chemical processes produced by ozone and the processes that destroy it. This equilibrium of the process is determined and depends on the amount of gases (involved in the reaction) and the speed (or efficiency of individual reactions), depending on the intensity of sunlight, location and area in the atmosphere, temperature and other natural
climate factors. Global ozone has declined steadily over the last few decades. The Earth's stratosphere has increased the amount of reactive gases, containing chlorine and bromine. The biggest impact on climate change is the carbon dioxide emission \( \text{CO}_2 \), due to the far-reaching emissions (measured in billions of tonnes per year). Among the "greenhouse gases" with the far-reaching "global warming potential" (GWP) are the so-called "Ozone gases" or substances that damage the ozone layer CFC and HCFC. Fortunately, there is a far smaller amount of these gases that reaches the atmosphere than \( \text{CO}_2 \).

1. Refrigerant
The cooling sector is one of the most important areas of energy in which ozone depleting substances are used. Namely, the most widespread working tools since DuPont introduced them to the market in the twenties of the last century are chlorofluorocarbons (hereinafter referred to as CFCs) and chlorofluorocarbons (hereinafter HCFCs), which appeared on the market a little later, are also used.

Significant changes in the use of refrigerants have occurred in the last decade, mainly in response to environmental issues, "hole in the ozone layer" and "global warming or greenhouse effect". Previously, there was not much dilemma in choosing a refrigerant because most of the needs could be met with well-known and well-tested fluids. The cooling sector is unique in that the ozone-depleting substances (ODS) are not only used in new devices but also in servicing existing equipment. Research on the field is carried out in relation to working assets, that are still in the existing correct systems that are in operation. They are replaced in accordance with the limits related to the time limit for their use. By evacuating from use, they are replaced with new working assets, which are thermodynamically suitable for them. Refrigerants is divided into: primary and secondary.

Primary refrigerants are those that are directly used in the cooling process. The primary refrigerants are grouped into the following four groups, shown in the table below. The scope of interest in this report is the group of F-gases.

**Table 1. Distribution of primary refrigerants [1-3]**

| No | Groups of primary refrigerants |
|----|-------------------------------|
| 1  | Halogenated carbonate refrigerants (so-called F-gases) |
| 2  | Azeotropic refrigerants |
| 3  | Inorganic refrigerants |
| 4  | Hydrocarbon refrigerants |

1.1. Halogenated carbonate refrigerants
Halogenated carbonate refrigerants belong to a group of artificial, synthetic refrigerants. These are halogenated derivatives of saturated hydrocarbons (CFC, HCFC and HFC). The trade name for them is freons or F-gases. The basic information about them is given in the table below.

**Table 2. List of Controlled and Alternative Substance [1-3]**

| No | Label | Chemical name | Properties |
|----|-------|---------------|------------|
| 1  | Aneks A | CFC | Group I – chlorofluorohydrocarbons |
|    |       |               | Group II – Halons |
| 2  | Aneks B | CFC | Group I – chlorofluorohydrocarbons |
|    |       |               | Other fully halogenated saturated hydrocarbon |
| Aneks C | Group II – carbon tetrahydrous derivatives |
|---------|------------------------------------------|
| HCFC    | Group III – trichloroethane              |
| HBFC    | Fully halogenated saturated hydrocarbon derivatives |

- **Aneks C**
  - HCFC: hydrochlorofluorocarbons
  - HBFC: Bromo Fluoro Coal

2. **Mixes controlled substances, the containers they contain:**
   - HCFC+PFC+HFC
   - Mixture they contain:
     - Bromohlorodifluormetan
     - Bromotrifluormetan
     - Dibromotetrafluoroetan

3. **New controlled substances**

4. **Alternative substances**
   - SF6: sulfur hexafluoride
   - HFC: Hydrofluorocarbons
   - PFC: Perfluorocarbons
   - Mixture alternative substances
2. Actual working substances and their control
In order to mitigate measures in the state of Bosnia and Herzegovina it is mandatory to implement operational programs and projects, control and reporting systems within the Montreal Protocol. Phase of the permit for the import and use of substances harmful to the ozone layer of CFC (R-11, R-12, R-502 ...) has been completed, and the next steps are being implemented.

2.1. Measures to implement the Montreal Protocol and deadlines for the abolition of CFC consumption
The Montreal Protocol specifies measures and deadlines for the gradual reduction and final exclusion, the abolition of production and consumption of ODS (ODS). For CFCs, these are the following deadlines:

1. For developed countries – 31 December 1999 / (January 2000),
2. For developing countries, the period of 10 years is still prolonged - December 31, 2009 / (January 2010).

2.2. Measures to implement the Montreal Protocol and deadlines for the elimination of HCFC consumption
HCFCs are substances that are less harmful to the ozone layer than CFCs. Contains hydrogen and chlorine. Perhaps the R-22 is the most commonly used in this group. The next phase is still in progress, import, use and implementation treatment in devices is controlled. Monitoring is carried out by relevant and responsible state institutions.

2.3. Measures to implement the Montreal Protocol. Research on new working substances
In addition to explosive (butane, propane), HFC and their mixtures are constantly on the market. The most well-known working substance from the HFC group is the one-component working substance R-134 a, which is mainly used as a replacement for R-12. HFCs are new environmentally friendly non-ozone-depleting substances (R-134a, R-404a, R-407 C, R-410A). In smaller home coolers today, the R-22 working substances are often replaced with the R-600a hydrocarbon. Substitutes for R-22 are the most commonly used working substance mixtures that can be azeotropic and zeotropic (R-404C, R-410A). Azeotropic working substances R-502 (CFC/HCFC), used in the past for lower cooling temperatures, are now most frequently replaced by a pseudo-zeotropic mixture of R-404a or an azeotropic mixture of R-507.

By the term "consumption" of working mediums, it is assumed that the total annual quantity (in ODP tonnes) of all substances in one group (eg CFC) is calculated in such a way that when the total annual quantity produced in the country concerned accrues the imported amount of these substances during the reporting period calendar year and take away the total exported amount of the same from the country. Therefore, consumption = production + import-export.

Since Bosnia and Herzegovina has no own production of any of the ODS, this means that for Bosnia and Herzegovina the "consumption" of each "control substance" is equal to the total amount of its annual imports.

3. Data on F-gases, emissions in Bosnia and Herzegovina, including sources of these gases
Ozone-Depleting Substances (ODSs) are chemicals / bromine-containing chemicals that contain chlorine or bromine (not in nature, but produced by humans), which have the potential to react to ozone molecules (chemical label- O_3) in the stratosphere. This ability of these chemicals, when they arrive at the atmosphere, the Earth's planetary stratosphere, and under the influence of ultra-violet sun rays, are themselves disintegrating, releasing chlorine or bromine, in their free state, break down destroy ozone molecules in the stratosphere, officially, according to the Montreal Protocol, is called
the degradation potential ozone (Ozone Depleting Potential - ODP) or often, in our domestic practice, called ozone depletion factor.

The reference substances for determining ODP, or the most commonly used substances in various sectors of industrial production, are CFC- compounds CFC-11 and CFC-12, with potential ODP = 1. Bosnia and Herzegovina is a member of the Vienna Convention and the Montreal Protocol and all amendments other than Beijing. Implementation of the Montreal Protocol and the gradual exclusion program from the use of ODS takes place through the Ozone Unit of Bosnia and Herzegovina at the Ministry of Foreign Trade and Economic. Relations, where public activities are undertaken.

Strategic documents were drafted on the basis of which Bosnia and Herzegovina fulfills its obligations for gradual exclusion from the use of ozone-depleting substances. But certain progress has been made, as many investments now use new equipment without ozone depleting substances. Many investment projects were made, through which the business entities received new equipment that did not use ODS and destroyed the old ones in their production processes among others:

- The depletion program for methyl bromide (the application of new technologies contributed to reducing the use of methyl bromide at 1,700 kg per year in 2001 to 100 kg in 2006),
- Project for the management and control of halons in Bosnia and Herzegovina - used in fire extinguishers in Bosnia and Herzegovina, the establishment of a control system for the import and consumption of halons, and training user's staff on international standards in handling halon equipment and protection against uncontrolled release, the use of alternative halon replacement substances, and the establishment of a halon center where halon will be collected which is no longer used for further recycling or destruction,
- RMP Program (Refrigiration Management Plan) Management Program in the Refrigeration Service Sector,
- Project for training and certification of service workers in the refrigeration,
- The project of national reclaiming centers for freon recycling (CFCs, HCFCs and their polymers).

The legal basis for the implementation of the Montreal Protocol on ODS, as an international agreement, accepted by Bosnia and Herzegovina on the basis of the succession of the obligations of the former joint state of SFR Yugoslavia (original) named:
- "Sl. list SFRJ MU ", No. 16/90,
- "Fig. list Republic Bosnia and Herzegovina ", No. 13/94,
- the "Montreal Protocol on Substances that Deplete the Ozone Layer" ("Official Gazette" of SFRJ MU", No. 16/90.

Official Gazette of the Bosnia and Herzegovina ), as its international obligation, is based on:
- The Law on the Procedure for the Conclusion and Execution of International Treaties of Bosnia and Herzegovina ("Official Gazette of Bosnia and Herzegovina No. 29/00)
- The Law on the Council of Ministers of Bosnia and Herzegovina ("Official Gazette of Bosnia and Herzegovina " No. 30/03 and 42/03), the decisions of the Council of Ministers on the conditions and manner of implementation of the Montreal Protocol and the gradual exclusion from the use of the ODS:

In particular, the decision of the Council of Ministers determines:
- Conditions for import and export of ODS, (licensing system, approval of quotas for import and issuance of import licenses),
- Conditions for importing and exporting devices, which contain as built-in or functionally use ODS.
Monitoring and controlling the import and export of these substances and products that contain or use the substances referred to in the preceding paragraphs and the reporting of relevant domestic and international institutions, organizations or authorities on import / export and annual consumption of these substances.

This decision also establishes the Program and Deadlines for the gradual exclusion from the use of ODS in Bosnia and Herzegovina, i.e. the most significant substances classified by the basic groups defined in the annexes of the Montreal Protocol and the decisions of the Conference to the Parties to the Montreal Protocol, which bind Bosnia and Herzegovina as a party to this international multilateral agreement / contract.

The dynamics of the gradual exclusion of ODS from use in Bosnia and Herzegovina, that is permitted quantities of imports / consumption of ODS in Bosnia and Herzegovina, by years and indicators of realized realization, are monitored on the basis of the official annual reports of Bosnia and Herzegovina to the authorities of the Montreal Protocol on Import and Consumption of ODS in Bosnia and Herzegovina.

4. Legislative law on Bosnia and Herzegovina entity
Implementation of the Montreal Protocol and the protection of the ozone layer, was also challenged by the entity laws. The Law on Air Protection (Federation of Bosnia and Herzegovina, "Official Gazette of the Federation of Bosnia and Herzegovina ", number: 33/03) Law on Air Protection (Republic of Srpska, Official Gazette of RS No. 53/02). By-laws in both entities (the Regulation of the Federal Ministry of Physical Planning on the gradual exclusion of ozone-depleting substances (ODP) and the Republic of Srpska Government Regulation on the gradual exclusion of ozone-depleting substances regulates the operational implementation of Bosnia and Herzegovina programs of gradual exclusion from the use of substances that damage the ozone layer ODS, especially in the following areas of activity:

1. The control and inspection of the devices in operation, which contain the ODS and the work of the service provider include,
2. Collecting ODS from the existing cooling units in operation,
3. Disposal of old or defective refrigeration units to landfills,
4. Establishment of the ODS Import / Export Register and Distribution in Bosnia and Herzegovina,
5. Obligations and manner of reporting of the importer ODS,
6. Obligations and rights of the competent entity institutions / ministries in the process of licensing and issuing licenses for import / export of ODS in Bosnia and Herzegovina.

Deadlines for the prohibition of import of key ODSs and equipment, which contains or use ODS obligations of Bosnia and Herzegovina according to the Montreal Protocol and its own (National) program for the gradual exclusion of ODS from use in Bosnia and Herzegovina.

Table 3. Time limits for exclusion, which Bosnia and Herzegovina is obliged to respect, according to the Montreal Protocol [2], [3]

| No | Time limits - exclusion                                  |
|----|---------------------------------------------------------|
| 1. | Methyl bromide                                         |
|    | From January 1, 2006..                                  |
| 2. | Halons                                                  |
|    | From January 1. januara 2007.                           |
| 3. | Methyl chloroform                                       |
|    | From January 1. januara 2007.                           |
| 4. | Equipment and devices that contain or use ODS           |
|    | From July 15, 2007.                                     |
5. A group of CFC compounds  From January 1, 2010.
6. A group of HCFC compounds  From January 1, 2020

The table below shows the values recorded in the past, long-term period, by 2010. Allowed/ planned and realized quantities (in tons) of imports/consumption of ODS in Bosnia and Herzegovina were shown for the period 2003-2010. [5]

| Groups ODS                        | 2003   | 2004   | 2005   | 2006   | 2007   | 2008   | 2009   | 2010   |
|-----------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| CFC                               |        |        |        |        |        |        |        |        |
| allowed                           | 235,30 | 167,00 | 102,10 | 63,00  | 43,00  | 23,00  | 3,00   | 0      |
| realized                          | 230,00 | 187,90 | 51,24  | 32,70  |        |        |        |        |
| Halons                            |        |        |        |        |        |        |        |        |
| allowed                           | 0,68   | 0,68   | 0      | 0      | 0      | 0      | 0      | 0      |
| realized                          | 0,38   | 0,38   | 0      | 0      |        |        |        |        |
| Methylchloroform (trichloroethane) |        |        |        |        |        |        |        |        |
| allowed                           | 17,00  | 17,00  | 11,00  | 5,00   | 0      | 0      | 0      | 0      |
| realized                          | 36,00  | 4,0    | 6,84   | 0      |        |        |        |        |
| Methyl bromide                    |        |        |        |        |        |        |        |        |
| allowed                           | 19,65  | 8,90   | 8,90   | 0      | 0      | 0      | 0      | 0      |
| realized                          | 16,40  | 12,60  | 1,29   | 0      |        |        |        |        |

4.1. Regulation of imports / exports of ODS in Bosnia and Herzegovina
Regulation of imports / exports of ODS in Bosnia and Herzegovina is done through licensing, quota and licensing systems for export / import, distribution and sale of ODS in the Bosnia and Herzegovina market. The most important procedures and procedures for:
- Submission of requests from economic organizations / legal entities and institutional competencies in Bosnia and Herzegovina for the implementation of the procedure for issuing licenses for import and export of ODS,
- Submission of requests from economic organizations / legal entities that have received the ODS import / export license for determining the quota (quantity) of annual ODS imports in Bosnia and Herzegovina,
- Submission of application and procedure for issuing licenses for import / export of ODS, for each individual contingent,
- Regulation of the import of equipment and devices, which contain or use ODS.

Import into the country or export from the country of renewed / recycled ODS, according to the Montreal Protocol, is not permitted. Keeping records (users) of the user / consumer ODS, as a rule, is done as follows:
- Keeping records of imports and exports of ODS by the Importers,
- Keeping records of distribution and sale of ODS in the Bosnia and Herzegovina market, by the Importers,
- Keeping records of consumption by ODS by producer or service economic organizations,
- Monitoring and control of import, export, sale and consumption of ODS, with inspection supervision (competent institutions of the entity and Brčko District)
- Preparation of data and information on import / export, distribution / sale and inventories of ODS for annual and occasional reporting of certain instances / institutions of Bosnia and Herzegovina.

The system of reporting on the import / export, consumption and distribution of ODS to the Bosnia and Herzegovina market - is done through reporting forms. In the system of compulsory reporting by various domestic and international factors, Bosnia and Herzegovina, as a party to the Vienna Convention for the Protection of the Ozone Layer and the "Montreal Protocol on ODS" and beneficiaries of the Multilateral Fund for the Implementation of the Montreal Protocol, (was and was still) obligatory to introduce and implement in practice reporting systems for at least the following areas of activities and activities:

- The annual report on import / re-export, distribution / sale on the Bosnia and Herzegovina market and ODS stocks, as of December 31 of the previous year, shall be submitted by each legal entity / company importer / exporter to the competent authority of the Entity, Brčko District. Reports are submitted on the prescribed forms (attached to the DECISION of the Council of Ministers),

- Annual Report on the Registration / Registration of ODS Imports in Bosnia and Herzegovina and Exports from Bosnia and Herzegovina is submitted by the Customs Sector Bosnia and Herzegovina - the relevant service - Ozone Unit of Bosnia and Herzegovina: Copy of the Reports: Entity Entities and Statistics Bureau of the Brčko District. Reports are submitted on the standardized forms of the Customs Service,

- Every annual report on the consumption of ODS in the production process and / or servicing of existing devices in operation shall be submitted by each economic entity / company / service workshop to the relevant entity institution or institution of the Brčko District,

- The Annual Report on Import / Export and Consumption of ODS in Bosnia and Herzegovina is submitted by the Bosnia and Herzegovina Ozone Unit - the Secretariat of the Montreal Protocol (Ozone Secretariat). Copies of reports: MLF, UNIDO, Bosnia and Herzegovina and Entity competent institutions,

- Reports shall be submitted on the standardized format of the Ozone Secretariat.

4.2. Implementation of the Montreal Protocol and the National Program for the Phasing-out of ODS in Bosnia and Herzegovina

Implementation of investment projects for technological restructuring of production capacities, with the transition from the use of controlled ODSs in the production process to the permitted substances (excluding ODS), as well as training projects and awareness raising on the need for protection of the ozone layer (approved and financed by MLF) Bosnia and Herzegovina Ozone Unit - MLF, at least once a year and at the end of each individual project, in particular.

Annual Report to the Multilateral Fund for the Implementation of the Montreal Protocol (MLF) is submitted by the Bosnia and Herzegovina Ozone Unit, on behalf of the Government of Bosnia and Herzegovina. Annual report in the usual format, and completion report, on standard MLF format. Annual Report on Import / Export and Consumption of ODS in Bosnia and Herzegovina, submitted by the Ozone Unit of Bosnia and Herzegovina to the Secretariat of the Montreal Protocol (Ozone Secretariat).

Copies of reports: Secretariat of the Montreal Protocol, UNIDO and relevant Bosnia and Herzegovina institutions for the field of environmental protection and international relations. Copies of the reports are submitted to the: Secretariat of the Montreal Protocol, UNIDO and the Council of Ministers (through the MVTEO). The following are the reports, officially registered numerically and submitted to the Ozone Secretariat for the period from 2010 to 2014 on a standardized format by
importers. Of the estimated amount of cooling and air conditioners, up to 50% of the same uses the old non-ecological freon R-22 (HCFC group) and R-12 (from the CFC group).

**Table 5.** List of devices in Bosnia and Herzegovina using CFC and HCFC, [psc] [3]

| Entity                  | Freeze   | Freezers  | Air - conditioners |
|-------------------------|----------|-----------|--------------------|
| Republic of Srpska      | 187,000 psc | 187,500 pcs | 50,000 pcs        |
| Federation              | 350,000 pcs | 350,000 psc | 125,000 psc       |
| Bosnia and Herzegovina  | 537,000 psc | 537,000 psc | 175,000 psc       |

**Table 6.** The amount of old-non-ecological freons R-22 and R-12 in refrigerated and air-conditioned, [kg]. [3]

| Entity                  | Freeze     | Freezers    | Air - conditioners | Total        |
|-------------------------|------------|-------------|--------------------|--------------|
| Republic of Srpska      | 187,500 pcs x 0.2 kg=37,500 kg | 187,500 pcs x 0.3 kg=56,250 kg | 50,000 x 1 kg=50,000 kg | 143,750 kg   |
| Federation              | 350,000 pcs x 0.2 kg=70,000 kg | 350,000 pcs x 0.3 kg=105,000 kg | 125,000 pcs x 1 kg=125,000 kg | 300,000 kg   |
| Bosnia and Herzegovina  | 537,500 pcs x 0.2 kg=107,500 kg | 537,500 pcs x 0.3 kg=161,250 kg | 175,000 pcs x 1 kg=175,000 kg | 443,750 kg   |

**Table 7.** Lists the quantities of controlled freons R-22 and R-12 in chains, cooling cabinets, cooling cabinets, cooling chambers in hospitals, dental clinics, cafes, pastry shops, butcher shops, bakeries, markets, various organizations, grocery stores, hypermarkets and the like, [pcs]

| Entity                  | Showcases | Cooling cabinets | Sanks      | Cooling chambers |
|-------------------------|-----------|------------------|------------|------------------|
| Republic of Srpska      | 100,000 pcs | 100,000 pcs     | 10,000 pcs | 5,000 pcs        |
| Federation              | 250,000 pcs | 250,000 pcs     | 25,000 pcs | 10,000 pcs       |
| Bosnia and Herzegovina  | 350,000 pcs | 350,000 pcs     | 35,000 pcs | 15,000 pcs       |

The quantity of old freons is by the free estimation still cc 30% for the above mentioned cooling devices, Table 8.

**Table 8.** The amount of old freons found in the above mentioned refrigerant devices, [kg]

| Entity                  | Showcases | Cooling cabinets | Sanks      | Cooling chambers |
|-------------------------|-----------|------------------|------------|------------------|
| Republic of Srpska      | 30,000 pcs x 1 kg=30,000 kg | 30,000 pcs x 1 kg=30,000 kg | 3000 pcs x 1,5 kg= 4,500 | 1500 pcs x 5 kg= 7,500 kg |
Federation

75,000 pcs x 1 kg = 75,000 kg

Bosnia and Herzegovina

105,000 pcs x 1 kg = 105,000 kg

Table 9. Total consumption of old freons found in the above mentioned cooling devices, [kg]

| Entity                          | Total Consumption |
|---------------------------------|-------------------|
| Republic of Srpska              | 72,000 kg         |
| Federacija                      | 248,250 kg        |
| Bosnia and Herzegovina          | 320,250 kg        |

Table 10. Total cooling and air conditioners in ships, boats, trains, buses, trucks-refrigerators, truck trucks, dumpers, etc.,(pcs)

| Entity             | Boats | Boats | Train | Buses | Refrigerated trucks | Trucks |
|--------------------|-------|-------|-------|-------|---------------------|--------|
| Republic of Srpska | 200 pcs | 300 pcs | 100 pcs | 1000 pcs | 500 pcs | 1000 pcs |
| Federation         | 400 pcs | 500 pcs | 150 pcs | 2500 pcs | 1000 pcs | 2000 pcs |
| Bosnia and Herzegovina | 600 pcs | 800 pcs | 250 pc | 3500 pcs | 1500 pcs | 3000 pcs |

The amount of old freons R-22 and R-12 in the aforementioned means of transport and according to the free estimation cc 30%, showed in Table 11.

Table 11. The quantity of old freons R-22 and R-12 by the means of transport, [kg]

| Entity             | Boats | Boats | Train | Buses | Refrigerated trucks | Trucks |
|--------------------|-------|-------|-------|-------|---------------------|--------|
| Republic of Srpska | 60 pcs x 20= | 90 pcs x 2= | 30 pcs x 15= | 300 pcs x 15= | 150 pcs x 20= | 300 pcs x 7= |
| Federation         | 120 pcs x 20= | 150 pcs x 2= | 45 pcs x 50= | 750 pcs x 15= | 300 pcs x 20= | 600 pcs x 7= |
| Bosnia and Herzegovina | 180 pcs x 20= | 240 pcs x 2= | 75 pcs x 50= | 1050 pcs x 15= | 450 pcs x 120= | 900 pcs x 17= |

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Table 12. Total quantity (consumption) of old freons R-22 and R-12 by the means of transport, [kg]

| No | Entity                                      | Total, [kg]  |
|----|--------------------------------------------|--------------|
| 1  | Total Consumption in Republic of Srpska     | 12,480 kg    |
| 2  | Total Consumption in Federation             | 26,400 kg    |
| 3  | Total Consumption in Bosnia and Herzegovina | 38,880 kg    |

5. Recapitulation of old non-ecological freons R-22 and R-12 found in cooling and air-conditioning units by entities in Bosnia and Herzegovina

Table 13. Recapitulation of old non-ecological freons R-22 and R-12 found in cooling and air-conditioning units by entities in Bosnia and Herzegovina

| Name of refrigeration device | The amount of freon in the cooling device in Republic of Srpska, [kg] | The amount of freon in the cooling device in Federation, [kg] | The amount of freon in the cooling device in Bosnia and Herzegovina, [kg] |
|------------------------------|-------------------------------------------------------------------------|----------------------------------------------------------------|--------------------------------------------------------------------------|
| Fridges                      | 37,500 kg                                                               | 70,000 kg                                                        | 107,500 kg                                                               |
| Freezer                      | 56,250 kg                                                              | 105,000 kg                                                      | 161,250 kg                                                               |
| Air-conditioners             | 50,000 kg                                                              | 125,000 kg                                                      | 175,000 kg                                                               |
| Refrigerated display         | 30,000 kg                                                              | 75,000 kg                                                        | 105,000 kg                                                               |
| Refrigerating cabinets       | 30,000 kg                                                              | 75,000 kg                                                        | 105,000 kg                                                               |
| Sanks                        | 4,500 kg                                                               | 11,250 kg                                                        | 15,750 kg                                                                |
| Refrigerating chambers       | 7,500 kg                                                               | 15,000 kg                                                        | 22,500 kg                                                                |
| Ships                        | 1,200 kg                                                               | 2,400 kg                                                         | 3,600 kg                                                                 |
| Boats                        | 180 kg                                                                 | 300 kg                                                           | 480 kg                                                                   |
| Trains                       | 1,500 kg                                                               | 2,250 kg                                                         | 3,750 kg                                                                 |
| Buses                        | 4,500 kg                                                               | 11,250 kg                                                        | 15,750 kg                                                                |
| Refrigerated trucks          | 3,000 kg                                                               | 6,000 kg                                                         | 9,000 kg                                                                 |
| Truck Trailers               | 2,100 kg                                                               | 4,200 kg                                                         | 6,300 kg                                                                 |
| Total                        | 228,23 kg                                                              | 502,650 kg                                                       | 730,880 kg                                                               |

Since we do not have a real population census, and with the number of 4,300 inhabitants in Bosnia and Herzegovina (Republic of Srpska 1,500 and Federation 2,800), one assessment of household-refrigerated appliances, air conditioners, which still use old freons can be performed.

6. Conclusion
Recapitulation of old non-ecological freon R-22 and R-12 which are found in cooling and air-conditioning devices according to entities and Bosnia and Herzegovina. How much and which cooling and air
conditioners use the old non-ecological freons (NEF) R-22 and R-12 is very difficult to estimate, and especially precisely, because there is no relevant institution in the Federation as well as in the Republic of Srpska, or Bosnia and Herzegovina, this issue. From long-time workers in this field, who are present in the field and who are continuously in practice, certain personal data have been obtained from their personal experience, which are not necessarily adequate to the actual situation. Due to war events in this region, and also after the war, this problem has not been seriously addressed, ie (non) use of non-ecological freons that destroy the ozone layer.

Europe, the United States and Australia were the first to deal with this problem, because highly developed and polluted the atmosphere the most, creating ozone holes, which forced them to ban in their territory the use of inadequate freons. They quickly switched to the use of ecological freons R-134a; R-404a; R-410; R-407C; R-507 to try to save the planet and the ozone layer in the atmosphere. Since 2000., it has been prohibited to use non-ecological freons in the aforementioned territories, but in the former Yugoslavia it has not been implemented in life-practice.

Newly emerged countries Croatia and Slovenia joined very quickly in Europe and prohibited the use of old non-ecological freons through their Laws on Ecology, while Bosnia and Herzegovina, Serbia, Macedonia and Montenegro still use the freons R-22 and R-12 much heavily. The situation in these countries was impossible to prohibit the use of cooling and air conditioners on old-age freons overnight, as almost 70% of the cooling and air-conditioning systems are still used. Once a free estimate, which is perhaps the most relevant at this time, is to take some sort of average at the level of the Republic of Srpska, the Federation, or Bosnia and Herzegovina.

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