Ministry for the Environment
Manatū Mō Te Taiao

New Zealand Climate Change Office
Te Tari Rerekētanga Āhuarangi o Aotearoa

Ways of limiting emissions of synthetic greenhouse gases used to replace ozone depleting substances in New Zealand

Discussion paper

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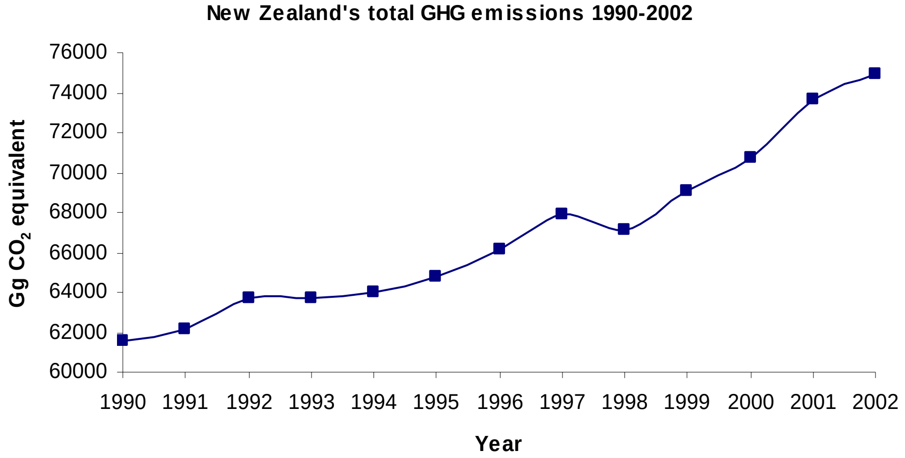
Greenhouse gas emissions - trends

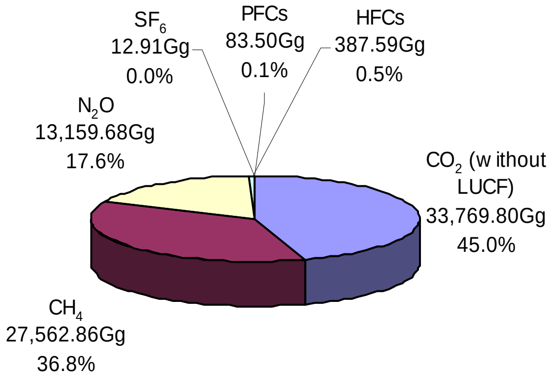
The New Zealand Greenhouse Gas Inventory released in 2004, shows New Zealand's total greenhouse gas emissions in 1990 were equivalent to 61,639.97Gg of CO_2. In 2002, total greenhouse gas emissions increased by 21.6 % to 74,976.34Gg CO_2 equivalent (Gg CO_2-e) (Figure 1). Over the period 1990 to 2002, the average annual growth in overall emissions was 1.65% per year.

Figure 1 New Zealand's total greenhouse gas emissions 1990-2002



Carbon dioxide (CO_2) and methane (CH_4) dominate New Zealand's greenhouse gas emissions (Figure 2). In 2002, these gases comprised 81.8% of total CO_2 equivalent emissions. Whereas CH_4 made the largest contribution to New Zealand's emissions in 1990, CO_2 is now the major greenhouse gas in New Zealand's emissions profile. The other major gas in New Zealand's emissions profile is nitrous oxide (N_2O).

Figure 2 New Zealand's emissions by gas in 2002 (all figures Gg CO_2 equivalent)



[LUCF = land use change and forestry]

The largest increases over the 1990 baseline include CO_2 and N_2O, with a smaller increase in CH_4.

What are synthetic greenhouse gases?

These ‘other gases’ are known collectively as synthetic greenhouse gases (SGGs) as they have little or no natural sources. SGGs include:

- Sulphur hexafluoride (SF_6)
    - used primarily as an insulator for high voltage electrical equipment
- Perfluorocarbons (PFCs)
    - mainly emitted from aluminium smelters, but also found is some refrigerant gases and can be used for specialised industrial processes including as a solvent
- Hydrofluorocarbons (HFCs)
    - used to replace ozone-depleting substances (ODS) in many applications in the refrigeration and air-conditioning sector and other related industrial processes such as the manufacture of plastic foams. HFC-134a is the most common HFC.

SGGs are also referred to by other names. In Europe in particular they are often referred to as F-gases as they all contain fluorine.

Again, according to the New Zealand’s Greenhouse Gas Inventory 2004, SF_6 emissions have increased 4.7% from 12.33 Gg CO_2-e per annum to 12.91 Gg CO_2-e per annum due to increased use in electric switchgear. Emissions of PFCs have decreased 83.8% from 515.6 Gg CO_2-e to 83.5 Gg CO_2-e due to improvements in the aluminium smelting process; and HFC emissions have increased from 0 to 387.59 Gg because of the use of HFCs as a substitute for the chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) that are being phased out under the Montreal Protocol. Together the SGGs contributed 484 Gg CO_2-e, or 0.65% of total emissions.

Although SGGs currently account for less than one percent of New Zealand’s greenhouse gas emissions, they are of particular concern because of their extremely high global warming potentials (GWPs)[1] relative to CO_2. Even relatively small absolute increases in their emissions would lead to a relatively large increase in CO_2-e greenhouse gas emissions.

Table 1 Common GWP values from the IPCC Second Assessment Report (1995)

Gas	Global warming potential
CO_2	1
CH_4	21
N_2O	310
HFC- 152a	140
HFC-134a	1,300

[1] Global warming potentials (GWPs) are used to convert emissions of each gas to an equivalent amount of CO_2 i.e. this allows different gases to be compared. GWPs represent the relative warming effect or cumulative radiative forcing, of a unit mass of the gas when compared with the same mass of CO_2 over a specific period. The UNFCCC reporting requirements (FCCC/CP/2002/8) specify that the 100-year GWPs contained in the IPCC Second Assessment Report (IPCC, 1995) are used in national inventories (Table 1).

Gas	Global warming potential
CF_4	6,500
C_2F_6	9,200
SF_6	23,900

Existing policies on synthetic greenhouse gases

Current government policy is that the greenhouse-gas emission charge will not apply to the synthetic greenhouse gases and there is no intention at this time that any charge would apply to SGGs.

The use and emissions of SF_6 in New Zealand is very small and is being addressed through a voluntary agreement with the major users. The emissions of PFCs from the aluminium smelter have already been addressed and emissions have dropped significantly in recent years. This leaves the use and emissions of hydrofluorocarbons and perfluorocarbons used as replacements for ODS being uncontrolled.

Growth in emissions of synthetic greenhouse gases

According to a report prepared by CRL Energy Ltd [2] for the New Zealand Climate Change Office (NZCCO) as part of the New Zealand Greenhouse Gas Inventory, the import of SGGs in bulk form (i.e. in pressure vessels, not in manufactured items) for the refrigeration and air-conditioning sector rose from 171 metric tonnes in 2000 to 345 tonnes in 2003. The estimated emissions (based on IPCC methodologies) also rose from 92 metric tonnes of SGG in 2000 to 178 tonnes of SGG in 2003.

Using published data on the number of vehicles registered in New Zealand and using industry estimates of the average amount of HFC in each imported vehicle, it is possible to estimate the maximum amount of HFC-134a contained in the air-conditioning systems (known as mobile air-conditioners (MACs)) of the imported vehicles. The data presented by CRL shows that there were 214,764 vehicles registered for the first time in 2003 and virtually all of these were fitted with MACs. Given that the average MAC system has a charge of 0.76 kg, this implies that up to 164 tonnes of HFC-134a may have been imported in the air-conditioning systems of these vehicles. It should be noted that many of the second-hand vehicles may not have had a full charge of gas at the time of arrival. Accordingly, an estimate of two thirds of the amount, or closer to 110 tonnes may be more realistic although there is no hard data to make an accurate calculation of this.

The amount of gas imported in vehicles is not likely to change significantly in coming years as all vehicles are now imported and virtually all are fitted with air-conditioning. However, the amount of HFCs needed to service this increasing number of MACs can be expected to continue to increase until the whole vehicle fleet has a MAC fitted.

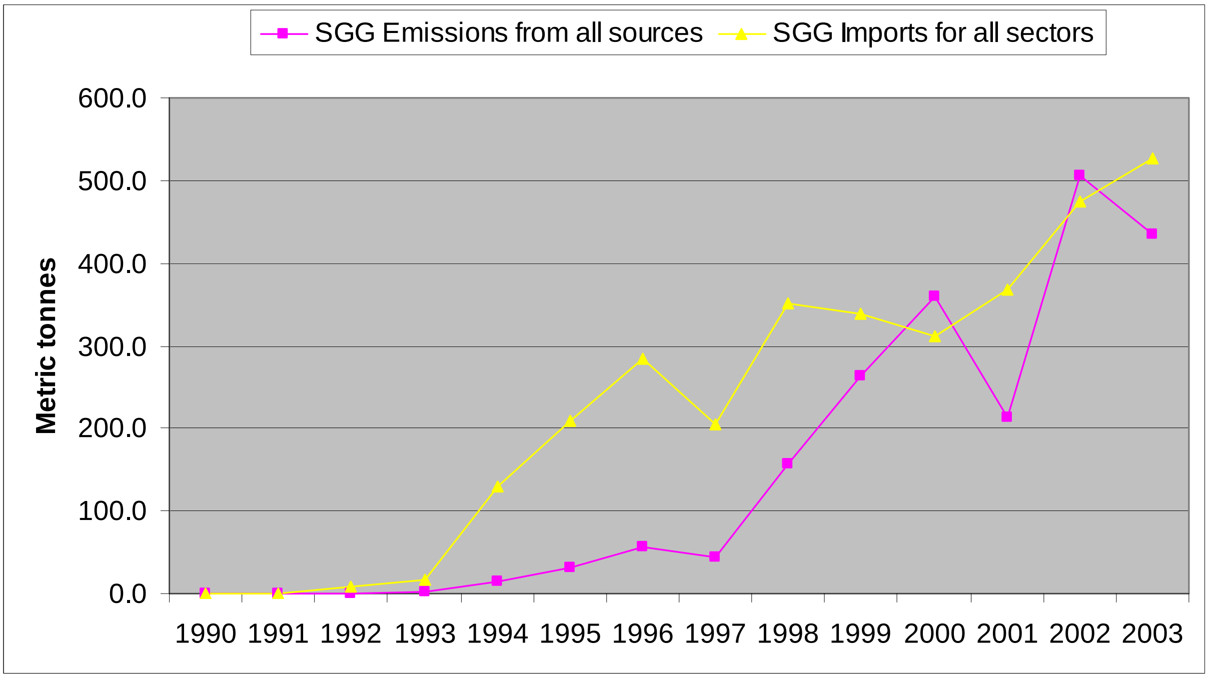
In addition to the HFCs in vehicles, CRL estimated that an additional 17 tonnes of SGGs was imported in other refrigeration and air-conditioning equipment. The amount of SGGs imported in these other products is also expected to increase significantly in the next few years. This is because the SGGs will be used to

[2] Inventory of HFC, PFC & SF_6 Emissions for New Zealand 2002-2003, CRL Energy ltd, 2004

replace ODS in equipment, but also because appliances such as heat pumps and dehumidifiers, which can use SGGs as the refrigerant gas, are increasing in popularity.

When data for imports from bulk sources and that found in finished equipment are included, along with emissions from both the stationary and mobile refrigeration and air-conditioning sectors, the results show significant increases in imports and emissions. See Figure 3.

Figure 3 Imports and emissions of synthetic greenhouse gases in the refrigeration and air-conditioning from all known sectors and sources (source CRL 2004)



Although there is reasonable data for total usage of SGGs in the refrigeration and air-conditioning industry, there is no data to identify which sector or sectors are using the SGGs. There is also no data on which sectors account for the increasing demand. It is reasonable to assume, based on the data for the types of gases being imported, that the growth in imports of HFC-134a is because of its increasing use in MACs. Imports of non-ozone depleting gases being used in the commercial refrigeration sector to replace HCFCs are also increasing. Of these replacement gases, the refrigerant R404A (a mixture of three SGGs) is by far the most important at present. Others, such as R410A (a mixture of two SGGs) which is being used to replace HCFC-22 in new air-conditioning units, are likely to become more important in time.

These growth patterns suggest that policy responses to reduce or limit emissions will need to work with both the stationary and the mobile refrigeration and air-conditioning industries. To date most of the discussions and work on voluntary approaches have concentrated solely on the stationary refrigeration and air-conditioning sector.

Possible controls on synthetic greenhouse gases

It is clear that although SGGs currently make up less than one percent of emissions of all New Zealand's greenhouse gases, the amount is going to increase in the next ten years. If New Zealand is to reduce or limit its emissions of SGGs, responses to date show that the existing voluntary programmes will not be sufficient on their own. The NZCCO has therefore developed this paper which outlines possible policy options to limit emissions of SGGs. Some of these options would require regulations to implement them. The proposals are informed by experiences with phasing out ozone depleting substances. It is possible that some of the proposals, if implemented, could also apply to ozone depleting substances.

In considering possible policy responses, the NZCCO has recognised that the SGGs are likely to be in use for many years. Unlike the ODS, which had definite phase-out dates, the SGGs are not being phased out. It is likely that imports of the bulk substances and equipment containing SGGs will continue to increase for some years. It is the intention of the policies put forward in the discussion document that they should reduce the emissions of these gases, rather than restrict imports or use.

When considering policy responses it is also important to consider that the direct emissions from the release of the SGGs can be dwarfed by the indirect emissions from the energy consumption of the appliance or machinery they are used in. For example, a domestic refrigerator contains around 120g of HFC-134a which, if released, would be equivalent to approximately 150 kg of CO_2. Whereas, the energy used to power the refrigerator over a 20-year lifetime could have released 5,000 kg of CO_2. There would be little or no advantage from limiting the use of SGGs if the use of an alternative substance resulted in higher indirect emissions through increased energy consumption.

Because the SGGs are likely to be used for much longer than ODS, it may be appropriate to consider policies (and in some cases reconsider policies) that may have been ruled out for ODS because of their costs or lack of short-term benefit. This document has not attempted to quantify the direct costs of the policies presented. It invites feedback on what the likely costs might be and whether these are appropriate.

In accordance with the relevant Cabinet decision on SGGs (October 2002 Cab Min (02) 26/16) the paper does not include policies on the use of SGGs in aerosols sprays. Because SGGs are expensive, their use has so far been restricted to applications where there are no safe alternatives. In general, this means for medial applications, such as ‘puffer’ sprays and those which require non-flammable sprays, such as for use on aircraft or live electronic equipment. No controls are proposed on these applications at this time.

New Australian controls

The Australian government has recently completed a lengthy process to decide how to control the use of synthetic greenhouse gases in Australia. After widespread consultation, the Australian government has decided to incorporate the SGG controls into their Ozone Act through an amendment. The industry in Australia appears to have been supportive of this decision as they see that it will ensure consistency of controls between SGGs and ODS. Equally importantly for the Australians, their new amendment act will ensure consistency of controls between their States. This has been a serious concern for their industry since controls on ODS were first introduced in the late 1980s.

A large number of companies in the refrigeration and air-conditioning sector operate in both the New Zealand and Australian markets. This is especially true at the importer and wholesaler level, with virtually all companies operating in both markets. At least in part because of the recent changes in Australia, the New Zealand refrigeration and air-conditioning industry and New Zealand government officials are looking at controls on ODS and SGGs in New Zealand. The New Zealand industry, through groups such as IRHACE has indicated that it would prefer to see a limited degree of controls introduced on SGGs now to ensure that emissions were minimised, rather than face significant changes at some future date, as happened with ODS controls in the late 1980s. They have also indicated that they would like to see consistent controls on ODS and SGGs.

During a series of meetings in 2003 and early 2004 between the NZCCO, the AGO and the refrigeration and air-conditioning industry in both New Zealand and Australia, a number of issues have been raised where further work was required. In particular, the consultation to date has raised the following issues for consideration in New Zealand:

- Refrigerant handling and in particular whether disposable cylinders should be banned.
    - Disposable cylinders are banned in Australia, but are not controlled in New Zealand.
- Training and licensing/accreditation for those handling SGGs
    - In Australia, accreditation for handling SGGs will be compulsory. In New Zealand, accreditation is currently voluntary.
    - Development of a joint code of practice is under way at present which will form the basis of the Australian accreditation programme.
- Emissions methodologies and reporting
    - Both countries have struggled to accurately estimate emissions under the IPCC framework. The Australians have proposed a joint study to identify better assumptions for emissions calculations.
- Options for disposal of SGGs if they are not able to be recycled
    - Both countries have an industry trust which pays for destruction of ODS. The costs of collection and destruction are paid for by a voluntary levy on ODS refrigerant sales. The New Zealand programme does not officially take back SGGs. The Australian scheme has been widened so that it will. There is an interest in expanding the New Zealand scheme to cover SGGs.
- Product Stewardship/Recovery
    - Regulations under the new Australian Act will include conditions on licensees importing products containing SGGs to ensure they contribute to the fund for destruction of SGGs. New Zealand does not have any comparable legislation.

The desirability of harmonising controls on businesses between New Zealand and Australia is generally accepted by the New Zealand refrigeration and air-conditioning industry and by both governments. The discussions in 2003 and early 2004 have fed into the ongoing work of the NZCCO to develop policies to limit emissions of SGGs. They have also been recognised by the NZCCO and the AGO in an agreement to work together on these issues known as the Australia – New Zealand Climate Action Partnership (ANZCAP).

The NZCCO is now considering various options for ensuring New Zealand's policies are compatible with the Australian controls, recognising the inherent differences between the two economies.

The following options are discussed in this paper:

- Accreditation of those handling SGGs
- Development of a Code of Practice
- Prohibition on the sale of disposable cylinders of refrigerant
- Ban on emissions of SGGs during handling
- Levy to pay for destruction of SGGs
- "Product stewardship" scheme to pay for destruction of SGGs in finished products
- Licences to import SGGs in bulk
- Licences to import products containing SGGs
- Manufacture and import prohibitions of products made with or containing SGGs
- No controls on SGGs in plastic foam manufacture at this time
- Possible legislative options to reduce SGG emissions

Options to control synthetic greenhouse gases

If the New Zealand government were to move beyond the existing voluntary controls on SGGs, such as the ‘No Loss Campaign’ and code of practice discussed below, then there are a range of ways to reduce emissions of SGGs that could be considered. Most of these have been identified as part of the discussions with the New Zealand and Australian industry. Some of these could be implemented as voluntary agreements with different sectors, but most would require some form of regulation to implement them.

The following section sets out some policy options for limiting SGG emissions. They are presented here in no particular order and include questions to guide feedback.

Accreditation of those handling SGGs

An accreditation scheme would establish a programme that requires all those who handle SGGs where they might be released to the atmosphere to have some formal qualification to show they know how to minimise leakage. At its most basic, an accreditation scheme provides a mandatory education programme for those who use the substances covered. In some countries, significant reductions in emissions of ODS were reported after the introduction of such schemes.

New Zealand is probably the only developed country that does not already have a mandatory accreditation scheme for those handling ODS. Most developed-country accreditation schemes for ODS are now being extended to cover SGGs. In this context, regulations being developed under the new Act in Australia include a nationally consistent, mandatory licensing regime for end users of ODS and SGGs in the refrigeration and air conditioning sector. This new mandatory regime will replace a myriad of, at times conflicting, State-level licensing schemes, as well as the voluntary nationwide licensing system known as the “ARCTick” scheme.

The New Zealand refrigeration and air-conditioning industry has long argued for the introduction of a mandatory accreditation scheme for ODS as a means of improving practices in their industry. In response to IRHACE’s submissions, the 1995 Ozone Layer Protection Bill was amended at the Select Committee stage to include a clause that allows the Minister for the Environment to require industry to develop an accreditation system to licence those who use ODS in their work. Although a draft scheme was developed by IRHACE at the Minister’s request in the late 1990s, it was never implemented in law.

IRHACE’s accreditation scheme was eventually launched in April 2002 as a voluntary scheme known as the “No Loss Campaign”. Some of the costs of the launch and promotion were met by the Ministry for the Environment (MfE). According to IRHACE, the scheme has not been a huge success. Initially it created a good level of interest, with more than 300 people being certified in the first year. However, since then fewer than 20 people have passed the qualification over and above those who sat the exam as part of their study at the training school. IRHACE has argued in several forums that the voluntary scheme is not working well and that the accreditation scheme should be made compulsory.

In Australia, the ARCTick scheme has at least four types of licences for different sectors of the industry (at a cost of AUS$55 for one or more licences). The scheme also recognises five different skill levels with different levels of licence required for different tasks. The examinations for the licences are ‘hands on’ and require testing of different levels of practical trade skills (e.g. ability to make joints in pipes) to specified academic course standards. This contrasts with the New Zealand ‘No Loss Campaign’ which only includes a theory component and tests awareness of environmental issues and good handling practices.

Key questions

1. Should there be a mandatory accreditation scheme for SGGs?
2. What substances should be covered?
    a. Should it also include ODS?
3. What sectors of industry should require accreditation?
    a. Should it be for all those who handle gas, or just supervisors?
    b. Should it include the installation of sealed units, such as window air-conditioners and some heat pumps where emissions are unlikely?
4. Should there be one accreditation exam for all users, or should sectors be able to develop specific schemes?
5. Should a scheme test practical 'hands on" skills, or just theory?
6. Should a licence scheme require ownership of specific tools as is required in Australia?

Development of a Code of Practice

Assuming a licensing/accreditation scheme was developed, it would require the development of a code of practice to set out the 'good practice' that the accreditation process would seek to test. A formally endorsed Code of Practice would also be necessary if it was to be referenced under Compliance schedules in the Building Code.

The NZCCO is contributing funds towards the development of a new code of practice covering all sectors of the refrigeration and air-conditioning industry. The code is being developed jointly with the AGO and the New Zealand and Australian industry under the ANZCAP initiative. It is expected to be completed by late 2004 – early 2005.

In Australia, some codes of practice can be given force of law and the language used must be carefully considered (i.e. whether clauses use 'must' and 'shall' or 'should' and 'may'). The legal status of the COP under New Zealand law has been raised in discussions as it has clear implications for the language of the new code. In New Zealand, compliance with previous COPs dealing with ODS has been voluntary. The only way by which they were enforceable was to state that compliance with the code was a defence against the Ozone Layer Protection Act's provisions that prohibited the release of ODS. The legal status of the new COP in New Zealand will need to be addressed before its completion.

Key question

7. Should a code of practice in New Zealand be legally enforceable?

Prohibition on the sale of disposable cylinders of refrigerant

In Australia, the government has banned the import of 'disposable' cylinders of HFCs (industry, under a voluntary agreement, has agreed not to import disposable containers of HCFCs). Disposable cylinders are relatively thin-walled cylinders and come in 13.6kg (30 pound) and 22kg (50 pound) sizes. Most refrigerants sold in New Zealand are sold in these cylinders and are known in the industry as 'jugs' or 'DACs' (the origin of the acronym is not clear, but appears to be a contraction of Disposable Cylinders).

The disposable cylinders have the advantage of being lightweight and easy to handle. They have the disadvantage that they are designed for only one use and must be disposed of once the gas has been removed. This poses two environmental problems. The first is the disposal of the cylinder and the second is the "heel"[3] of gas left in the cylinder at the time of disposal. The amount of the heel varies with pressure and temperature, but when multiplied by many thousands of cylinders the amount that could be lost to the atmosphere at the time of disposal becomes significant.

Many countries have banned the use of disposable cylinders on environmental grounds. These include the EU and Australia. However, the cylinders remain common in the US and Asia.

In addition to the 13.6 kg DACs there are also small 1 pound/500gm 'DIY' cans. These are primarily sold to car owners to allow them to top up their own car air-conditioning systems. In countries like the US they were a major part of the CFC market prior to their being controlled. The concern is that the use of these cans does not encourage the repair of leaks. The cans also do not allow the charge to be measured. This means there will usually be over-pressurisation (leading to greater leakage in time) or some percentage of the can's charge will be lost to atmosphere at the time of use. There is little, if any use of these cans in New Zealand so any prohibition would primarily be to prevent future growth.

An industry group has been formed to develop an industry position on the ongoing use of all kinds of disposable cylinders. In particular, the group is expected to determine how many cylinders are used in New Zealand, how they are disposed of, and what happens to any gas in them at the time of disposal. Their conclusions will feed into the policy development process.

Key questions:

8. Should there be any restrictions on the import or sale of disposable cylinders of refrigerants?
9. Should the import and sale of small 1 pound/500gm 'DIY' cans be prohibited?

Emissions bans

One of the core provisions of the Ozone Layer Protection Act(s) was to make it an offence for anyone who:

> *Knowingly or without lawful justification or excuse releases a controlled substance into the atmosphere while -*
>
> > *(i) Installing, operating, servicing, modifying, or dismantling any refrigeration or air-conditioning equipment or other heat-transfer medium; or*
> >
> > *(ii) Installing, servicing, modifying, or dismantling any fire extinguisher.*

This clause was virtually impossible to enforce in practice, but represented a clear statement of government policy. It was also the legal justification for ensuring industries' compliance with the codes of practice.

Without a similar clear statement of policy from the government on the release of SGGs, the refrigeration and air-conditioning industry representatives have argued that voluntary and industry-based programmes to reduce emissions will have very limited effect, as there is no formal incentive to encourage compliance.

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[3] NB if a pump is not used to empty the contents, there will still be a small amount of gas left in the cylinder once the cylinder reaches atmospheric pressure. This residual amount is referred to as the "heel".

Key question

10. Should there be a ban on the emissions of synthetic greenhouse gases?

Levy to pay for destruction of synthetic greenhouse gases

There is already a voluntary industry Trust that collects a $1 per kg levy on all ODS refrigerant sold in New Zealand. The levy is collected by a stand-alone private company known as the ‘Ozone Protection Company’. The scheme has wide, although not universal, support and it has been well managed. MfE was actively involved in the early ‘90s in establishing the Trust that oversees the scheme.

Because the company only collects income on ODS refrigerants, it will only pay for the destruction of ODS refrigerants. In order to include SGGs, the Trust would need to be broadened to collect funds on these. There are several impediments to this. The Trust Deed for the existing Company is reported to be inflexible and initial discussions suggest it might be easier to develop a new Trust with a new deed rather than to re-negotiate the existing one. It is also likely that the relative importance of some sectors will be greater (especially that of the MAC sector) and therefore the Trust that oversees the administration of the funds may need a different structure. The refrigeration and air-conditioning industry is reportedly interested in developing a new Trust, but preparatory discussions only commenced in June 2004 on this.

Although various options for making the levy mandatory were considered at the time the original Trust was established, there were no obvious mechanisms to allow any levy collected by the government to not simply be treated as a tax. If the funds collected were treated as a tax, they would likely remain in the government’s current account and it would not be possible to guarantee access to the funds for the purpose for which they were collected. There are precedents for the government to be involved in the collection of levies, most noticeably for the former producer boards. However, if the private sector is able to implement the levy on bulk substances without government, there appears to be little need for direct government involvement through regulations.

Key questions

11. Should the government be involved in establishing a fund to pay for destruction of SGG refrigerants?
12. If a levy system is established, should the government remain involved in the administration of the scheme?
13. Should the government be involved in promoting any industry trust of SGG collection scheme?

‘Product stewardship’ or ‘extended producer responsibility’ scheme

One of the possible impediments to the successful introduction of a voluntary levy on the import of bulk refrigerants is the very large amount of HFC being imported in new and second hand cars and in built up heat pumps and other refrigeration and air-conditioning equipment. According to the 2004 CRL report on emissions of SGGs, 17 metric tonnes of HFCs and PFCs may have been imported in refrigeration and stationary air-conditioning products. In addition, calculations based on the number of vehicles registered in 2003 suggest that up to 165 tonnes of HFCs were imported in vehicles in 2003. This estimate compares with the 345 tonnes of HFCs and PFCs imported in bulk.

Under the existing arrangements, finished products such as vehicles or heat pumps do not contribute to the levy for ODS destruction. It is likely that the refrigeration and air-conditioning industry would have very real concerns about the fairness of any voluntary scheme that did not include some way of receiving payment for the gas imported in finished products.

In New Zealand, programmes to manage special wastes such as used oil are increasingly based on the concept of 'extended producer responsibility (EPR)' under which producers should take responsibility for the end of life management of products and materials they put on the market. Extended Producer Responsibility is a key principle in the 2002 New Zealand Waste Strategy.

To overcome the difficulties of getting importers of finished products to contribute to a levy for destruction of the gases, the Australian Regulations require all licence holders (for both pre-charged equipment and bulk substances) to participate in a 'product stewardship' scheme. Product stewardship refers to an obligation on importers and manufacturers to be responsible for their products after the purchaser has finished using them (and is the same concept as an EPR scheme). In the Australian example, importers of products containing SGGs, such as motor vehicles and heat pumps, will contribute to programmes to collect and destroy the SGGs at the end of the product's life. Product stewardship can also cover the responsibility of service companies to ensure service technicians comply with all relevant controls to minimise emissions during warranty repairs.

The new Australian controls will require all importers of products containing SGGs to belong to a government-approved product stewardship scheme. This scheme will be responsible for disposal of the gases imported. As the regulations are still being drafted, there are no approved product stewardship schemes.

Key questions

14. Should the NZ government require importers of finished products containing SGGs to contribute to a fund for destruction of the SGGs at the end of the product's life?
15. If introduced, should all products including aerosols and plastic foam be required to contribute to a fund, or should the levy be only on those where the gas can be recovered under current technologies (i.e refrigeration and air-conditioning equipment)?
16. Should importing companies be allowed to establish their own schemes, or should there only be one government-approved scheme?

Licences to import synthetic greenhouse gases

At present, the collection of data for imports and emissions of SGGs is by survey. If controls are to be introduced on SGGs, then it may be appropriate to extend the requirement for import permits that currently apply to ozone depleting substances to include all of the SGGs (including SF_6). Permits could be issued on demand and at low, or no cost. The main advantage of requiring import permits is that it would provide an official record of all importers, ensuring greater reliability of the data collection required under the United Nations Framework Convention on Climate Change (UNFCCC). Because data is currently collected by survey of importers, it is clearly only possible to collect information from importers which are already known to the NZCCO. By creating an official record of importers, the accuracy of surveys would be improved.

In Australia the government has agreed to charge substantial fees for SGG import permits (AUS$15,000 per licence valid for two years for import of bulk substances, and AU$3,000 per licence for two years to import equipment pre-charged with HFCs or HCFCs) and a small fee per kg of substance as well. The fee is set to recover costs of implementing the licensing system, but is clearly a disincentive to small and 'one-off' imports. At this stage, such a high level of fees is not being proposed for New Zealand, but it remains an option that could be considered.

Regulations could also be used to require permitted importers to report to the NZCCO on amounts of gases actually imported.[4] This may be important in the future as is it is not practical to use the Tariff Code to monitor imports of mixtures. In the Tariff Code, refrigerant mixtures are all classified under one heading and cannot be identified separately. As most of the replacements for the ozone-depleting substances are two- and three-part mixtures of SGGs (for example R404A and R410A) the identification of these products will be increasingly important. Import permits would ensure the collection of more accurate data on the import of mixtures.

Key questions

17. Should the government require import permits for SGGs in bulk form?
18. Should it be a requirement of an import permit to report data on actual imports to the NZCCO?
19. Should the government charge a fee for an import permit? If so, how much?

Licences to import products containing synthetic greenhouse gases

In addition to requiring information on the amount of SGGs imported in bulk, the reporting methodologies and guidelines used under the UNFCCC also require countries to monitor imports of SGGs in finished products.

It would be possible to require products containing SGGs to have an import licence. Import licences would provide a more accurate method of determining the level of imports of finished products. The licences could also be used as a way to enforce contributions to any 'product stewardship' scheme. If introduced, licences would be issued on demand and there is no intention that they would be used to restrict or prohibit the import of products at this time.

There are obvious difficulties to requiring import permits for finished products. In particular, the costs, both to Government and to the private sector, of implementing a licensing scheme may be significant. There are also practical difficulties as it can be difficult to determine at the border what, if any, SGGs are contained in a product. In most cases refrigeration and air-conditioning equipment has a label on it that identifies the refrigerant (to allow future servicing) but other equipment, especially plastic foam, may require destructive testing to determine if it contains an SGG.

As with permits to import bulk substances, it is suggested that if a permit was required it would be available at low or no cost. However, charging a high fee as a disincentive for imports remains an option.

An alternative approach to requiring import permits for products would be to look at creating new statistical keys in the Tariff of New Zealand (HS codes) to more accurately specify which products do or

[4] The NZCCO already has the power to legally require importers to provide information on greenhouse gases under the Climate Change Response Act 2002. It must be noted though, that specific regulations to create the power to collect data on SGGs do not exist at this time. Regulations would still be necessary if legal authority was required.

do not contain SGGs. Amending the Tariff of New Zealand would assist with reporting obligations under the UNFCCC, but is not likely to assist with ensuring compliance with any ‘product stewardship’ or ‘extended producer responsibility' schemes.

Key Questions

20. Should the government require import permits for all SGGs in finished products?
21. Should some types of products, such as plastic foams, not require import permits?
22. Should it be a requirement of an import permit to report data on the quantity of SGGs imported in the equipment to the NZCCO?
23. Should the government charge a fee for an import permit? If so, how much?
24. Are there other options, such as introduction of new statistical keys in the Tariff of New Zealand that could provide information on imports of finished products containing SGGs?

Manufacture and import prohibitions

One possible option to reduce emissions of SGGs would be to ban imports (and manufacture where appropriate) of specific products that contain SGGs. This option was used when CFCs were phased out. Because New Zealand is primarily a technology ‘taker’ it is not likely that New Zealand could ban imports of products before other industrial economies had made the investment in alternatives. As of 2004, it is not clear that there are commercially available alternatives for SGGs in many applications.

It is likely that any import bans in New Zealand would be of symbolic value, and would be unlikely to lead to changes in global production or consumption of SGGs. It is also likely that bans could have very high economic costs, but low environmental gains if there were no commercially viable alternatives, or they resulted in increased energy consumption.

No import or manufacture bans are suggested at this time. Should these circumstances change and alternatives to SGGs become widely available, the issue could be investigated again.

Key question

24. Should New Zealand be prohibiting the import of any products that are made with, or contain synthetic greenhouse gases?
    a. If so, which products should be considered for bans?

No controls on SGGs in plastic foam manufacture at this time

At present, most plastic foam in New Zealand is manufactured using hydrocarbons as the ‘blowing’ agent. A relatively small amount uses HCFC-141b or HCFC 142b as the blowing agent. As the Montreal Protocol and New Zealand legislation is phasing out the supply of the HCFC gases, manufacturers are again looking for alternatives. These are likely to include synthetic greenhouse gases. In particular, HFC-134a, HFC-245fa and HFC-365mfc have been suggested as possible replacements. It is also possible that some of the PFCs could be used in specific circumstances. All of the HFCs mentioned have relatively high GWPs. [5]

At this time, there is no international consensus of the likely demand for HFCs as blowing agents in the next 10-15 years. The industrial processes that utilise the gases are too new for the industry to have established what the best practices are, or where non-ODS and no- or low-GWP alternatives are, or are not, available. It is reasonable to assume that because the HFCs being suggested are significantly more expensive than hydrocarbons, the HFCs will only be used where there are good technical reasons. These reasons are likely to include situations where insulation properties are important (a possible example is in the walls of hot water cylinders) or where there are technical constraints to using a flammable gas at the foam-manufacturing site.

It is possible that if other controls are introduced that would apply to all SGGs users, such as a requirement for import permits to import bulk SGGs and possibly a requirement to produce codes of good practice, then these would apply to the foam sector. However, because it is not possible to predict the level of demand for SGGs in foam manufacturing and because there is little or no consumption at this time, no controls are proposed specifically for the sector. The need for specific controls should be reviewed again in four or five years, once options and alternatives are better understood.

Key question

25. Should the use of SGGs to manufacture plastic foams be controlled?
    a. If yes, what type of controls would be appropriate for the foam-manufacturing sector?

Legislative options to reduce synthetic greenhouse gas emissions

If the government were to introduce legislative controls on SGGs, several possible Acts could be used. The most obvious of these are the Ozone Layer Protection Act 1996, the Building Bill 2003 and the Climate Change Response Act 2002.

Ozone Layer Protection Act 1996

The Ozone Layer Protection Act 1996 does not cover SGGs and was not intended to cover them. The Act allows regulations to be made controlling most aspects of the import, handling and release of ODS. It also allows for the Minister for the Environment to request organisations or individuals to prepare codes of practice and accreditation schemes. Because there is a complete overlap between the uses of ODS and SGGs (excluding SF_6 in the electricity industry and PFCs emitted from the aluminium smelter), the structure, provisions and regulation making powers could be amended to apply controls on SGGs with only minor changes to the Act.

[5] HFC-134a = GWP 1,300, HFC-245fa = GWP 950 and HFC-365mfc = GWP 890 over 100 years. (Source Chapter 4 of the Working Group I report of the IPCC Third Assessment Report)

The use of the OLPA would ensure consistency of controls between ODS and SGGs and reduce any possibility for conflicting requirements. It could also provide an opportunity to achieve some additional reductions in emissions of ODS through improved practices in all aspects of handling refrigerant gases.

As noted above, after extensive consultation, the Australian government decided to modify their Ozone Act, rather than create a new Act to manage synthetic greenhouse gas emissions.

Building Act 1991/Building Bill 2003

The new Building Bill, which is expected to come into law in late 2004, could cover the use of synthetic greenhouse gases in the building industry. According to a Ministry of Economic Development (MED) discussion document:

> *"The government is proposing to amend the Building Act to introduce a licensing system for building practitioners. Licensed building practitioners will be required to undertake or supervise critical building activities."*

Some have suggested the Bill provides an opportunity to control SGGs (and presumably ozone depleting substances) within the building industry.

The new Bill's definition of "building" is very clear that it does not cover motor vehicles and other forms of transport such as trains and boats which may have both refrigeration and air-conditioning systems installed. As these other sectors are possibly larger users of SGGs than the building sector, their omission is too large to ignore. While there is clearly scope to work with the building industry, the Building Bill/Act does not provide enough coverage of SGG users to be useful on its own.

The Building Bill envisages the development of "Compliance Schedules".

> *"A Compliance Schedule is a document issued by the Territorial Authority listing the inspection, maintenance and reporting procedures for certain systems and features in a building (such as lifts, fire alarms, air conditioning) to ensure their continued safety of operation. (Not required for single residential dwellings.)"*

Compliance Schedules may provide a framework for ensuring that once installed, refrigeration and air-conditioning equipment that contain SGGs are properly serviced and thus reduce emissions. These will be dealt with under the Building Code, which is currently being reviewed. It is possible that the Building Code could include reference to the soon to be developed Code of Good Practice on reducing emissions of SGGs in the refrigeration and air-conditioning industries and possibly to any licensing/accreditation scheme for those handling SGGs.

Climate Change Response Act 2002

The Climate Change Response Act (CCR) 2002's stated purpose is:

> *(1)The purpose of this Act is to enable New Zealand to meet its international obligations under the Convention and the Protocol, including, but not limited to -*
>
> > *(a) its obligation under Article 3.1 of the Protocol to retire units equal to the number of metric tonnes of carbon dioxide equivalent of human-induced greenhouse gases emitted from the sources listed in Annex A of the Protocol in New Zealand in the commitment period; and*

(b) its obligation to report to the Conference of the Parties via the Secretariat under Article 7 of the Protocol and Article 12 of the Convention.

The CCR Act can therefore be used to collect data on consumption and emissions of SGGs. However, it does not contain any regulation making power that could be used, for example, to prohibit the use of disposable refrigerant cylinders, or to require those handling SGGs to undergo appropriate training.

Any efforts to use the CCR Act would require a significant amendment to incorporate SGGs. This is an option, but does not appear to have any immediate advantages over amendments to the Ozone Layer Protection Act.

Other legislative options

There are other acts, such as those controlling workers in the electrical industry, those controlling dangerous goods (i.e pressure vessels) and more general regulation making powers to control imports, such as the Imports and Exports (Restrictions) Act 1988 that could be used to control either those handling SGGs or the import of the gases themselves. There also remains the option of an entirely new Synthetic Greenhouse Gas Control Act. These more general controls have not been considered here, as they do not appear to offer any advantages over amendments to the above Acts.

Key question

26. If New Zealand is going to introduce regulations to reduce emissions of SGGs, should it amend the Ozone Layer Protection Act, create a new Synthetic Greenhouse Gas Emissions Control Act, or use other existing regulation making powers?

Please send your feedback to:

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Appendix I

List of key questions raised in discussion document

Accreditation of those handling SGGs

1. Should there be a mandatory accreditation scheme for SGGs?
2. What substances should be covered?
   a. Should it also include ODS?
3. What sectors of industry should require accreditation?
   a. Should it be for all those who handle gas, or just supervisors?
   b. Should it include the installation of sealed units, such as window air-conditioners and some heat pumps where emissions are unlikely?
4. Should there be one accreditation exam for all users, or should sectors be able to develop specific schemes?
5. Should a scheme test practical 'hands on' skills, or just theory?
6. Should a licence scheme require ownership of specific tools as is required in Australia?

Development of a Code of Practice

7. Should a code of practice in New Zealand be legally enforceable?

Prohibition on the sale of disposable cylinders of refrigerant

8. Should there be any restrictions on the import or sale of disposable cylinders of refrigerants?
9. Should the import and sale of small 1 pound/500gm 'DIY' cans be prohibited?

Emissions Bans

10. Should there be a ban on the emissions of SGGs?

Levy to pay for destruction of SGGs

11. Should the government be involved in establishing a fund to pay for destruction of SGG refrigerants?
12. If a levy system is established, should the government remain involved in the administration of the scheme?
13. Should the government be involved in promoting any industry trust of SGG collection scheme?

Product stewardship scheme

14. Should the New Zealand government require importers of finished products containing SGGs to contribute to a fund for destruction of the SGGs at the end of the product's life?
15. If introduced, should all products including aerosols and plastic foam be required to contribute to a fund, or should the levy be only on those where the gas can be recovered under current technologies (i.e refrigeration and air-conditioning equipment)?
16. Should importing companies be allowed to establish their own schemes, or should there only be one government-approved scheme?

Licences to import SGGs

17. Should the government require import permits for SGGs in bulk form?
18. Should it be a requirement of an import permit to report data on actual imports to the NZCCO?
19. Should the government charge a fee for an import permit? If so, how much?

Licences to import products containing SGGs

20. Should the government require import permits for all SGGs in finished products?
21. Should some types of products, such as plastic foams, not require import permits?
22. Should it be a requirement of an import permit to report data on the quantity of SGGs imported in the equipment to the NZCCO?
23. Should the government charge a fee for an import permit? If so, how much?
24. Are there other options, such as introduction of new statistical keys in the Tariff of New Zealand that could provide information collected on imports of finished products?

Manufacture and import prohibitions

25. Should New Zealand be prohibiting the import of any products that are made with or containing synthetic greenhouse gases?
    a. If so, which products should be considered for bans?

Controls on SGGs in plastic foam manufacture

26. Should the use of SGGs to manufacture plastic foams be controlled?
    a. If yes, what type of controls would be appropriate for the foam-manufacturing sector?

Possible legislative options to reduce SGG emissions

27. If New Zealand is going to introduce regulations to reduce emissions of SGGs, should it amend the Ozone Layer Protection Act, create a new Synthetic Greenhouse Gas Emissions Control Act, or use other existing regulation making powers?

Appendix II: Background

What is climate change?

Over millions of years, our climate has undergone many changes – from ice ages to tropical heat and back again. Natural changes have generally been gradual, allowing people and other species to adapt or migrate, although some prehistoric climate changes may have led to the mass extinction of species.

Greenhouse gases trap the warmth from the sun and make life on Earth possible. Without them, too much heat would escape and the surface of the planet would freeze. However, over the previous 50 to 100 years, the concentration of the greenhouse gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) in the atmosphere has been increasing. The concentration of CO_2 has increased 31% since 1750, the concentration of CH_4 has increased 151% and the concentration of N_2O has increased 17% (IPCC, 2001). The increased concentration produces an 'enhanced greenhouse effect' that causes Earth to heat up (i.e. global warming) and the climate to change. The Intergovernmental Panel on Climate Change (IPCC) 3rd assessment report (IPCC, 2001) notes that the effects of climate change due to the 'enhanced greenhouse effect' will be different in different parts of the world. However, in general, temperatures and sea levels are expected to rise, rainfall patterns may change in many areas, and the frequency of extreme weather events are expected to increase. The IPCC concluded the most of the observed warming over the past 50 years is likely to be due to the emission of greenhouse gases by human activities, and that the changes ahead of us will happen more quickly than any recent natural climate variations.

The UNFCCC & the Kyoto Protocol

In 1990, the Intergovernmental Panel on Climate Change (IPCC) concluded that human-induced climate change was a real threat to our future. In response, the United Nations General Assembly convened a series of meetings that culminated in the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) at the 'Earth Summit' in Rio de Janeiro in May 1992. The UNFCCC took effect on 21 March 1994 and has been signed and ratified by 188 nations, including New Zealand.

The main objective of the UNFCCC is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (caused by humans) interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

All countries that ratify the UNFCCC are required to address climate change through greenhouse gas inventories, national or regional programmes and preparing for adaptation to the impacts of climate change. Developed countries agreed to non-binding targets to reduce greenhouse gas emissions to 1990 levels by 2000. However, by 2000 only a few countries made appreciable progress towards achieving their targets. The international community recognised that the UNFCCC alone was not enough to ensure greenhouse gas levels would be reduced to safe levels, and that more urgent action was needed. In response, the Parties to the UNFCCC negotiated the Kyoto Protocol.

The Kyoto Protocol aims to reduce the total greenhouse gas emissions of developed countries (and countries with economies in transition) to 5% below the level they were in 1990. The Protocol sets reduction targets for the greenhouse gas emissions of developed countries for the period 2008 to 2012, referred to as the first commitment period. Different countries have different targets to achieve. New

Zealand's target is to reduce its greenhouse gas emissions to the level they were in 1990 or take responsibility for any excess emissions.

The Protocol has to be signed and ratified by 55 countries (including those responsible for at least 55% of the developed world's 1990 CO_2 emissions) before it can enter into force. As at July 2004, 123 countries accounting for 44.2% of CO_2 emissions in 1990 have ratified the Protocol. New Zealand ratified the Kyoto Protocol on 19 December 2002.

Appendix III: Environmental Data for Historical, Current, and Candidate Refrigerants

Refrigerant number (R-)	Chemical formula - common name	Composition (%)	Atmospheric lifetime (yr)	ODP	GWP (100 yr)	Treaty covered by
CFC-11	CCl_3F			1	4600	Montreal
CFC-12	CCl_2F_2			0.82	10600	Montreal
BCFC-12B1	$CBrClF_2$ - halon			5.1	1300	Montreal
CFC-13	$CClF_3$		640	1	14000	Montreal
BFC-13B1	$CBrF_3$ - halon 1301			12	6900	Montreal
FIC-13I1	CF_3I		<0.1	0	1	
FC-14	CF_4 - carbon tetrafluoride		50000	0	5700	Kyoto
HCFC-21	$CHCl_2F$		2	0.01	210	Montreal
HCFC-22	$CHClF_2$		11.9	0.034	1700	Montreal
HFC-23	CHF_3 - fluoroform 70.01		260	0	12000	Kyoto
HCC-30	CH_2Cl_2 - methylene chloride		0.46	0	10	Montreal
HCFC-31	CH_2ClF			0.1	0.01	Montreal
HFC-32	CH_2F_2 - methylene fluoride		5	0	550	Kyoto
HCC-40	CH_3Cl - methyl chloride		1.3	0.02	16	Montreal
HFC-41	CH_3F - methyl fluoride		2.6	0	97	Kyoto
HC-50	CH_4 - methane		12	0	23	Kyoto
CFC-113	CCl_2FCClF_2		85	0.9	6000	Montreal
CFC-114	$CClF_2CClF_2$		300	0.85	9800	Montreal
CFC-115	$CClF_2CF_3$		1700	0.4	7200	Montreal
FC-116	CF_3CF_3 - perfluoroethane			0	11900	Kyoto
HCFC-123	$CHCl_2CF_3$		1.4	0.012	120	Montreal
HCFC-124	$CHClFCF_3$		6.1	0.026	620	Montreal
HFC-125	CHF_2CF_3		29	0	3400	Kyoto
HFE-E125	CHF_2-O-CF_3		150	0	14900	
HFE-E134	CHF_2-O-CHF_2		26.2	0	6100	
HFC-134a	CH_2FCF_3		13.8	0	1300	Kyoto

Refrigerant number (R-)	Chemical formula - common name	Composition (%)	Atmospheric lifetime (yr)	ODP	GWP (100 yr)	Treaty covered by
HCFC-141b	CH_3CCl_2F		9.3	0.086	700	Montreal
HCFC-142b	CH_3CClF_2		19	0.043	2400	Montreal
HFC-143a	CH_3CF_3		52	0	4300	Kyoto
HFE-E143a	CH_3-O-CF_3		4.4	0	750	
HFC-152a	CH_3CHF_2		1.4	0	120	Kyoto
HCC-160	CH_3CH_2Cl - ethyl chloride		20.6	<1	0	Montreal
HFC-161	CH_3CH_2F - ethylfluoride		0.3	0	12	Kyoto
HC-170	CH_3CH_3 - ethane			0	~20	
HE-E170	CH_3-O-CH_3 - dimethylether		0.015	0	1	
FC-218	$CF_3CF_2CF_3$ - perfluoropropane		2600	0	8600	Kyoto
HFC-227ea	CF_3CHFCF_3		33	0	3500	Kyoto
HFC-236fa	$CF_3CH_2CF_3$		220	0	9400	Kyoto
HFC-245fa	$CHF_2CH_2CF_3$				950	Kyoto
HFE-E245cb1	CH_3-O-CF_2-CF_3		4.7	0	160	
HC-C270	-CH_2-CH_2-CH_2- - cyclopropane			0	0	
HC-290	$CH_3CH_2CH_3$ - propane			0	~20	
FC-C318	-CF_2-CF_2-CF_2-CF_2-		3200	0	10000	Kyoto
HFE-E347mmy1	CF_3-CF(OCH_3)-CF_3					
R-400(50/50)	R-12/114	(50.0/50.0)		0.835	10000	Montreal
R-400(60/40)	R-12/114	(60.0/40.0)		0.832	10000	Montreal
R-401A	R-22/152a/124	(53.0/13.0/34.0)		0.027	1100	Montreal
R-401B	R-22/152a/124	(61.0/11.0/28.0)		0.028	1200	Montreal
R-401C	R-22/152a/124	(33.0/15.0/52.0)		0.025	900	Montreal
R-402A	R-125/290/22	(60.0/2.0/38.0)		0.013	2700	Montreal
R-402B	R-125/290/22	(38.0/2.0/60.0)		0.02	2300	Montreal
R-403A	R-290/22/218	(5.0/75.0/20.0)		0.026	3000	Montreal
R-403B	R-290/22/218	(5.0/56.0/39.0)		0.019	4300	Montreal
R-404A	R-125/143a/134a	(44.0/52.0/4.0)		0	3800	Kyoto
R-405A	R-22/152a/142b/C318	(45.0/7.0/5.5/42.5)		0.018	5200	Montreal
R-406A	R-22/600a/142b	(55.0/4.0/41.0)		0.036	1900	Montreal

Refrigerant number (R-)	Chemical formula - common name	Composition (%)	Atmospheric lifetime (yr)	ODP	GWP (100 yr)	Treaty covered by
R-407A	R-32/125/134a	(20.0/40.0/40.0)		0	2000	Kyoto
R-407B	R-32/125/134a	(10.0/70.0/20.0)		0	2700	Kyoto
R-407C	R-32/125/134a	(23.0/25.0/52.0)		0	1700	Kyoto
R-407D	R-32/125/134a	(15.0/15.0/70.0)		0	1500	Kyoto
R-407E	R-32/125/134a	(25.0/15.0/60.0)		0	1400	Kyoto
R-408A	R-125/143a/22	(7.0/46.0/47.0)		0.016	3000	Montreal
R-409A	R-22/124/142b	(60.0/25.0/15.0)		0.039	1500	Montreal
R-409B	R-22/124/142b	(65.0/25.0/10.0)		0.033	1500	Montreal
R-410A	R-32/125	(50.0/50.0)		0	2000	Kyoto
R-410B	R-32/125	(45.0/55.0)		0	2100	Kyoto
R-411A	R-1270/22/152a	(1.5/87.5/11.0)		0.03	1500	Montreal
R-411B	R-1270/22/152a	(3.0/94.0/3.0)		0.032	1600	Montreal
No designated R number in 2002	R-1270/22/152a	(3.0/95.5/1.5)		0.032	1600	Montreal
R-412A	R-22/218/142b	(70.0/5.0/25.0)		0.035	2200	Montreal
R-413A	R-218/134a/600a	(9.0/88.0/3.0)		0	1900	Kyoto
R-414A	R-22/124/600a/142b	(51.0/28.5/4.0/16.5)		0.032	1400	Kyoto
R-414B	R-22/124/600a/142b	(50.0/39.0/1.5/9.5)		0.031	1300	Montreal
R-415A	R-22/152a	(82.0/18.0)		0.028	1400	Montreal
R-415B	R-22/152a	(25.0/75.0)		0.009	520	Montreal
No designated R number in 2002	R-22/152a	(52.0/48.0)		0.018	940	Montreal
No designated R number in 2002	R-22/152a	(60.0/40.0)		0.02	1100	Montreal
R-416A	R-134a/124/600	(59.0/39.5/1.5)		0.01	1000	Montreal
R-417A	R-125/134a/600	(46.6/50.0/3.4)		0	2200	Kyoto
R-418A	R-290/22/152a	(1.5/96.0/2.5)		0.033	1600	Montreal
R-419A	R-125/134a/E170	(77.0/19.0/4.0)		0	2900	Kyoto
No designated R number in 2002	R-22/124/600	(50.0/47.0/3.0)		0.029	1100	Montreal
No designated R number in 2002	R-23/32/134a	(4.5/21.5/74.0)		0	1600	Kyoto

Refrigerant number (R-)	Chemical formula - common name	Composition (%)	Atmospheric lifetime (yr)	ODP	GWP (100 yr)	Treaty covered by
No designated R number in 2002	R-23/125/143a	(20.0/36.0/44.0)		0	5500	Kyoto
No designated R number in 2002	R-32/125/134a/600	(10.0/42.0/45.0/3.0)		0	2100	Kyoto
No designated R number in 2002	R-32/125/143a	(10.0/45.0/45.0)		0	3500	Kyoto
No designated R number in 2002	R-32/125/143a/134a	(2.0/41.0/50.0/7.0)		0	3600	Kyoto
No designated R number in 2002	R-32/125/143a/134a	(10.0/33.0/36.0/21.0)		0	3000	Kyoto
No designated R number in 2002	R-32/134a	(25.0/75.0)		0	1100	Kyoto
No designated R number in 2002	R-32/134a	(30.0/70.0)		0	1100	Kyoto
No designated R number in 2002	R-125/22	(70.0/30.0)		0.01	2900	Montreal
No designated R number in 2002	R-125/134a/152a	(35.0/40.0/25.0)		0	1700	Kyoto
No designated R number in 2002	R-125/143a/290/22	(42.0/6.0/2.0/50.0)		0.017	2500	Montreal
No designated R number in 2002	R-125/152a/227ea	(40.0/5.0/55.0)		0	3300	Kyoto
No designated R number in 2002	R-134a/142b	(80.0/20.0)		0.01	1500	Montreal
No designated R number in 2002	R-134a/142b	(80.6/19.4)		0.008	1500	Montreal
No designated R number in 2002	R-134a/142b	(88.0/12.0)		0.005	1400	Montreal
No designated R number in 2002	R-161/13I1	(80.0/20.0)		0	9.8	
No designated R number in 2002	R-161/218/13I1	(65.4/18.2/16.4)		0	1600	
No designated R number	R-170/290	(6.0/94.0)		0	~20	Montreal

Refrigerant number (R-)	Chemical formula - common name	Composition (%)	Atmospheric lifetime (yr)	ODP	GWP (100 yr)	Treaty covered by
in 2002						
No designated R number in 2002	R-218/134/600	(32.7/62.8/4.5)		0	3500	Kyoto
No designated R number in 2002	R-290/600a	(50.0/50.0)		0	~20	
No designated R number in 2002	R-600a/600	(50.0/50.0)			~20	
R-500	R-12/152a	(73.8/26.2)		0.605	7900	Montreal
R-501	R-22/12	(75.0/25.0)		0.231	3900	Montreal
R-502	R-22/115	(48.8/51.2)		0.221	4500	Montreal
R-503	R-23/13	(40.1/59.9)		0.599	13000	Montreal
R-504	R-32/115	(48.2/51.8)		0.207	4000	Montreal
R-505	R-12/31	(78.0/22.0)		0.642		Montreal
R-506	R-31/114	(55.1/44.9)		0.387		Montreal
R-507A	R-125/143a	(50.0/50.0)		0	3900	Kyoto
R-508A	R-23/116	(39.0/61.0)		0	12000	Kyoto
R-508B	R-23/116	(46.0/54.0)		0	12000	Kyoto
R-509A	R-22/218	(44.0/56.0)		0.015	5600	Montreal
No designated R number in 2002	R-32/600	(90.0/10.0)		0	500	Kyoto
No designated R number in 2002	R-32/600	(95.0/5.0)		0	520	Kyoto
No designated R number in 2002	R-32/600a	(90.0/10.0)		0	500	Kyoto
No designated R number in 2002	R-32/600a	(95.0/5.0)		0	520	Kyoto
No designated R number in 2002	R-134a/600a	(80.0/20.0)		0	1000	Kyoto
No designated R number in 2002	R-218/152a	(83.5/16.5)		0	7200	Kyoto
R-600	CH_3-CH_2-CH_2-CH_3 - butane			0	~20	
R-600a	$CH(CH_3)_2$-CH_3 - isobutane			0	~20	

Refrigerant number (R-)	Chemical formula - common name	Composition (%)	Atmospheric lifetime (yr)	ODP	GWP (100 yr)	Treaty covered by
R-601	CH_3-CH_2-CH_2-CH_2-CH_3 - pentane		<<1		11	
R-601a	$(CH_3)_2CH$-CH_2-CH_3 - isopentane			0		
R-610	CH_3-CH_2-O-CH_2-CH_3 - ethylether			0		
R-611	$HCOOCH_3$ - methylformate			0		
R-630	$CH_3(NH_2)$ - methylamine			0		
R-631	CH_3-$CH_2(NH_2)$ - ethylamine			0		
R-704	He - helium			0		
R-717	NH_3 - ammonia			0	<1	
R-718	H_2O - water			0	<1	
R-729	air			0	0	
R-744	CO_2 – carbon dioxide		>50	0	1	
R-764	SO_2 – sulfur dioxide			0		
HCC-1130	CHCl=CHCl - dielene					
HC-1150	$CH_2=CH_2$ - ethylene			0		
HC-1270	$CH_3CH=CH_2$ - propylene			0	~20	

Source:
United Nations Environment Programme (UNEP), 2002 Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee.

NOTE: The data presented in this Table are based on international scientific assessments and reflect the latest consensus determinations on potential impacts. However, the reduction requirements and allocations under the Montreal Protocol and many national regulations pursuant to it use older, adopted values. Similarly, emission reporting pursuant to the Kyoto Protocol are based on data from the 1995 IPCC assessment /IPC96/ rather than the updated 2001 assessment /IPC01