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COMITÉ EXÉCUTIF DU
FONDS MULTILATÉRAL AUX FINS
D'APPLICATION DU PROTOCOLE DE MONTRÉAL
Vingt-huitième réunion
Montréal, 14-16 juillet 1999

STRATÉGIE D'ÉLIMINATION DES HALONS EN INDE

Ce document comprend :

Partie A: Observations du Secrétariat du Fonds

Partie B: Le document «India Halon Phase-out Strategy» proposé par le PNUD au nom du gouvernement de l'Inde

Partie A

OBSERVATIONS DU SECRÉTARIAT DU FONDS

Description du projet

1. La treizième réunion du Comité exécutif, tenue en juillet 1994, a approuvé la somme de 309 000 $US pour le PNUD aux fins de démonstration de technologies de remplacement pour les extincteurs d'incendie et la préparation d'une technologie d'élimination des halons en Inde par l'entremise du Defense Institute of Fire Research de l'Inde à Delhi, Inde.

2. La consommation de base de halon 1211 en Inde est de 100 tonnes (300 tonnes ODP) et de 100 tonnes de halon 1301 (1 000 tonnes ODP), la consommation moyenne pour la période 1995-1997, ce qui représente 1 300 tonnes ODP. La stratégie révèle que la demande de halon 1211 vierge a diminué en Inde même si la consommation de halon 1211 et de halon 1301 se situe à 100 tonnes par année pour les années ayant servi à l'établissement de la consommation de base.

3. L'Inde prévoit éliminer 95 % de son utilisation de halons d'ici 2002 et parachever l'élimination du secteur des halons, à l'exception de quelques utilisations critiques/essentielles, d'ici 2005.

4. Il y avait deux fabricants de halons en Inde en 1995, dont un (M/s NFI), qui a terminé sa production en 1995. L'autre fabricant, M/s SRF, possède une capacité de production de 600 tonnes. Le taux de production moyen de halon en Inde pour la période de consommation de base (1995-1997) est de 178,7 tonnes de halon 1211. Bien que l'Inde soit en mesure de fabriquer 400 tonnes de halon 1301, la stratégie révèle qu'il n'y a eu aucune production commerciale de halon 1301 en Inde à ce jour.

5. La stratégie recense cinq agents de remplacement pour la protection contre les incendies et évalue leur utilisation, leur compatibilité et leur acceptabilité. La stratégie termine son évaluation en affirmant que les substances suivantes sont des produits de remplacement convenables pour les extincteurs portatifs en Inde : la poudre ABC, le CO_2, le HFC et les composés à base de HFC tels que le NAF-4, le halotron et le FE-36. Elle conclut que les substances suivantes peuvent être considérées comme des produits de remplacement convenables pour l'Inde dans certaines circonstances : le HFC-227ea, les composés à base de HCFC (NAF-SIII), le HFC-23, les intergaz, la vapeur d'eau et les systèmes à base de CO_2 en cabine et sous le plancher.

6. Le plan d'action comprend la mise en œuvre continue et l'approbation de projets sur les halons 1211 et 1301, la clôture des activités de fabrication de halons, la mise en œuvre de la fabrication de poudre ABC (sans aide, par l'industrie), la création d'un groupe d'experts sur les utilisations essentielles des halons, la révision des normes et des codes, l'adoption de lois interdisant les nouvelles installations de nouveaux systèmes à base de halons, la fabrication de nouveaux extincteurs aux halons, la gestion et la création de banques de halons et un programme d'éducation/sensibilisation.

7. Le coût total de la mise en œuvre de la stratégie du secteur a été établi à 5,1 M$US, ventilé comme suit:

Création du groupe d'experts sur l'utilisation des halons	150 000 $US
Fabricants d'extincteurs et de systèmes fixes au halon	1 400 000
Révision des normes et des codes	50 000
Fin de la production de halons	2 500 000
Programme national de banques de halons	500 000
Programme de formation et d'éducation	500 000

Observations

8. Le Comité exécutif a déjà réglé plusieurs aspects de la stratégie, dont l'approbation de 10 projets sur les halons en Inde évalués à plus de 1,7 M$US (comprenant les frais des agences) qui devraient donner lieu à l'élimination de 1 410 tonnes ODP, une fois menés à terme. Cette quantité est semblable à la valeur de base de 1995-1997 de 1 300 tonnes ODP. De plus, le Secrétariat du Fonds a recommandé à la vingt-huitième réunion du Comité exécutif d'accorder son approbation générale à six projets supplémentaires dans le secteur des extincteurs à incendie et systèmes fixes.

Gestion et banques de halons

9. La stratégie comprend également une étude menée par le programme des banques de halons sur les risques associés à la vidange des halons, les essais des systèmes/installations, le maintien des stocks des principaux utilisateurs (surtout militaires), l'élaboration de procédures sur la manutention des stocks, l'équipement de récupération/recyclage du halon 1301, la formation sur la récupération et le recyclage des halons, la mise en service d'un centre de recyclage des halons et un projet de formation des formateurs sur la réduction des futurs besoins essentiels.

10. Les centres d'entretien de l'équipement à base de halon 1301 profitent des services de centres de valorisation des halons et de formation sur les technologies de remplacement créés dans le cadre des projets approuvés à ce jour et recommandés pour les projets restants sur les halons 1211 et 1301 admissibles au financement du Fonds multilatéral. De plus, l'équipement de valorisation du halon 1211 a également été fourni aux fabricants d'extincteurs qui ne font pas l'entretien des systèmes fixe à base de halon 1301.

11. Cette approche a pour but d'aider ceux qui assurent actuellement l'entretien des systèmes à base de halon 1301 à continuer à répondre aux besoins d'entretien des systèmes domestiques en fournissant du halon 1301 valorisé.

Fin de la production des halons

12. La vérification des installations de fabrication des halons est en cours.

Révision des normes et des codes

13. Le Comité exécutif a approuvé la somme de 75 000 $US pour l'élaboration par le PNUE d'un manuel des normes et des codes des bonnes pratiques pour le secteur des halons. Ce manuel est destiné aux bureaux de l'ozone et aux agences de protection contre les incendies. Il comprendra de l'information sur les codes de pratique, les normes pertinentes, des exemples de lois et les spécifications pour les assurances. Le manuel comprendra également des conseils ou des suggestions clés sur l'élaboration de codes, de normes et de lois semblables dans les pays en développement. Il sera élaboré en collaboration avec la Fondation nationale de recherches sur la protection contre les incendies de l'Inde et le Comité des choix techniques pour les halons. Le manuel devrait être complété au mois de juillet 1999.

Groupe d'experts sur les utilisations essentielles des halons

14. Les activités du groupe d'experts sur les utilisations essentielles des halons seront intégrées au programme de renforcement des institutions de l'Inde. Le renouvellement de ces programmes est assujetti aux lignes directrices du Comité exécutif concernant leur niveau de financement.

Programme d'éducation et de formation

15. Le programme d'éducation et de formation a surtout pour but de former les membres du groupe d'experts sur les utilisations essentielles des halons et de réviser les normes, les codes et les manuels. La stratégie ne se prononce pas sur le genre de formation qui sera offerte.

Part B

SECTION - 1
Executive Summary

1.1 India ratified the Montreal Protocol on control of substances that deplete the ozone layer in June 1992 along with its London Amendment (1990). Since then, India has been implementing the ODS phase out programmes in accordance with the time schedules set out for Article 5(1) countries. India has been able to accelerate the phase out in sectors like foam & aerosol where technical & financial support is being provided by Multilateral Fund. The Draft Ozone Depletion Substances (Regulation) Rules 1998 published in the gazette of Indian stipulate closure of productions of halon based equipment & systems by 1-1-2001 with some exception for critical/ essential uses where known alternatives are unsuitable. The legislation has already been enacted to restrict import & export of halons.

1.2 The present strategy has been prepared keeping in view the national & international scenario and based on fire safety without halon. The strategy assumes that all technical & financial support will be provided by Montreal Protocol Multilateral fund in order to meet the protocol obligations and projects both investment as well as institutional strengthening will be expeditiously approved for conversion and adoption of alternative technologies on fair and favorable terms.

1.3 Fire protection in home & industry is an essential requirement under various Acts & Regulations in India. India is self sufficient in portable extinguisher except for certain specialised applications like Aircraft use. India, however, depended on import of Halon-1301 and relevant hardware. India used about 550 MT of Halon-1211 in 1991 & 162 MT in 1997 and 200 MT of Halon-1301 in 1991 & 58.5 MT in 1997. These figures are ODP tons. It means there is an almost 70% reduction in consumption of both the halons. Most of the portable extinguishers using Halon-1211 can be replaced by conventional types like CO2 & ABC powder. CO2 gas is available in large quantities where as ABC powder will be required to be imported. However, cylinders for both would need to be modified. In India, Halon-1301 system servicing will continue with imported recycled gas & new systems limited to essential uses only as defined in section 6. About 10 MT each of Halon 1211 and 1301 are likely to continue for certain essential uses till substitutes are available. 8 conversion projects of Halon 1211 have been approved for funding by MLF and another 6 are in the pipeline for submission to the MLF in 1999. Projects that will cover the halon production sector should also be presented to the Multilateral Fund in 1999.

1.4 Replacement agents for Halon-1301 have been imported, installed and demonstrated at Defence Institute of Fire Research, financed by Multilateral Fund. Following technologies have been identified at present as substitutes for Halon-1301 :-.

- HFC - 227 (FM-200)
- HFC-23 (FE-13)
- HCFC - blend (NAF-SIII)
- Inert gases
- Water mist (Low pressure) and
- CO2 in-cabinet sub-floor system

1.4.1 Replacement agents for H-1211 extinguisher at present are ABC Powder and CO_2 squeeze grip valve extinguishers.

1.4.2 The appropriate substitute shall be adopted after analysing the risk and keeping economic cost of replacement at minimum.

1.5 For adoption of above alternative technologies the strategy defines the methodology such as changing of specifications, codes, standards, laws and regulations. Though new substitute systems have approvals in various advanced countries, the national law will require National Standards in order to get approvals and also insurance cover. Accordingly financial assistance has been sought for about US $ 5.1 million that includes funding of investment projects like conversion of Halon based equipment and system manufacturing, production closure of Halon 1211 and 1301, addition/revision of standards, education and training programme, formation of expert panel for guidance to the industry and advising ozone cell on essentiality use criteria and possible exemptions thereof. The details of funds required under each activity are given in Table 11.

1.6 A number of regulations/ incentives for ODS reduction are already in place such as no financial support to new investments in ODS using industry, restriction on Export/Import of ODS, ECO mark for ODS free technologies, ban on production of halons and regulation on sales, purchase and reporting of ODS use etc will be in place very soon.

1.7 The Action Plan suggests continuation of awareness programmes on ozone layer protection, conversion projects, new standards, legislative and administrative action & banking plans. It is expected to phase out 95% of Halon use by the year 2002 and complete phase out by 2005 except for a few critical/ essential applications

SECTION - 2
Introduction

2.1 Due to the high Ozone Depleting Potential ODP of halons, the availability of alternatives for majority of uses of halons and sufficient halons stored in existing installations world over to serve critical applications, the production of halons in Article 2 countries has stopped since Dec 1993, six years ahead of the original phase out schedule.

As an Article 5 country, India has a 10 year grace period and an obligation to stop the consumption of halons by year 2010. With the accelerated phaseout schedule in developed countries and the special request from the Executive Committee of the Multilateral Fund (MLF), financial support for the halon subsector unlike other CFCs sectors is subject to the conditions that :-

- A total halon phaseout strategy is developed and agreed.
- An accelerated phaseout schedule is adopted.
- A legislative control on halon consumption is defined in the strategy
- Halon equipment conversion projects are prepared for the whole sector or at least in groups of 4/5 companies at the same time.

2.2 Halon Phaseout Schedule

2.2.1 Article 2 Countries

- Production stopped - Dec. 1993.
- Use allowed till Dec. 2000 (Recycled Halon)
- Essential uses will continue

2.2.2 Article 5(1) Countries

- Freeze halon consumption and production in 2002 at the average level of 1995-97
- Reduce Production by 50% of average of 1995-97 by 2005.
- Stop Production by 2010 with possible exemption up to 15% of 1995-97 average to meet essential uses.

2.3. In order to meet the demand and obligation of the Montreal Protocol, different phaseout scenarios have been examined and evaluated. Following experiences have been taken into account when evaluating possible phaseout strategies :-

a) One of the main consumers of halons in India applied for funding for conversion of their halon extinguisher production in 1995 and started changing to non-ODS production. Their project had been approved for funding at a cost which is insufficient for a conversion project of this kind.

b) Request for funding to start the development and planning of a halon management and recycling programme was prepared in the beginning of 1994 to meet the foreseen shortage of halons, especially for halon-1301. The project was not approved and cannot be resubmitted before a strategy of halon banking is prepared and approved by Executive Committee of Multilateral Fund.

c) A project funded by MLF at the cost of US $ 309,000 for demonstration, evaluation of halon alternative technologies and preparation of India's halon phaseout strategy has proved to be quite useful in technology identification and preparation of this strategy document.

d) As a spin off of (c) above, seven more projects for Halon extinguisher and system conversion have been approved for US $ 940,000 for Indian Industry.

e) Cost effectiveness thresholds have been introduced, which was not in the original Montreal Protocol. Indian industries feel that all eligible projects and costs must be funded. Nevertheless eight companies whose projects are approved and funds sanctioned have voluntarily accepted to meet the rest of cost of their projects.

2.4. Taking into account the above experience and observations, following two phaseout plans have been identified and evaluated :-

a) No action to be taken and leave question of halon phase out to market forces; the halon manufacturing companies, the fire protection industry, owners and users of halon fire fighting equipment etc.

b) Bring legislation to stop production and installation of new halon based fire fighting equipment from Dec 2000 except for essential uses and supply existing equipment and installations by a limited production or import of halons for their servicing and refilling requirements. Limit halon emissions through halon management programmes and use of halon recycling equipment; Limit Halon emissions through discharge tests, training and demonstrations etc.

2.5 The total cost, ODS impact and technological advantage of both the strategies have been examined. It is agreed by all that "no action" will lead to continued halon production and will prevent the fire protection industry from unnecessary technological lag and achieving the necessary technical and financial support. The second plan which allows limited use of Halon for servicing, maintenance and future critical uses and technical & financial support to industry have been developed in this strategy.

2.6 **Principles on which the Strategy is based**

The following principles have been followed when formulating this strategy :-

(a) The main philosophy behind the strategy is that there will be no compromise with life and fire safety including social & national security as a result of Halon phaseout in the country.

(b) The strategy suggests special provisions/ continued use for certain critical uses in defence, aviation, marine, offshore etc

(c) It is assumed that the Multilateral Fund will fund all eligible cost for halon phaseout projects both in production & user sector in Indian Industry.

(d) It is assumed that alternative technologies will be made available to Indian Industries on fair and favorable terms. Technology transfer and adaptation should take place smoothly and in the most cost effective way both to the Indian economy and to the Multilateral Fund.

(e) Halon conversion projects will be expeditiously approved & implemented with support from the implementing agency.

(f) The Indian Government with financial support from the MLF will form an expert group (Essential Use Panel) for technical guidance to Industry and users in the field of halon-free fire safety and make recommendations for possible exemption for essential uses of Halon and import/exports etc.

(g) This strategy paper will act as guide for Fire Protection without Halon & will be updated from time to time.

(h) Incentives, disincentives, policies and regulation will be the tools for the success of this strategy.

(i) In designing this strategy the international environment, other relevant conventions / protocols, phase out strategy of other ODS sectors in India have been taken into account.

SECTION - 3
Sector Background

3.1 Fire Services In India

3.1.1 Fire Services in India are heterogeneous in character. Responsibility of safety of life and property against fire hazards is resting with fire brigades of municipalities/local bodies in some states, while for others it rests with state Government fire services/police fire services. Defence has its own fire services. A large number of public sector industries and organisations are having fire fighting cover by Central Industrial Security Forces, which has a large fire wing within its setup. There are individual industrial fire brigades in both public and private sectors in addition to the existence of fire brigades in Railways, Power, Defence, fertilizer, Ports, National/International Airports, Oils & Petrochemical, etc.

3.1.2 Ministry of Home Affairs is the nodal Ministry for fire service matters and the Fire Advisor assisted by Deputy Fire Adviser under Director General of Civil Defence is responsible for dealing with fire advisory functions as required. Fire protection including equipment & extinguishers are installed in private sector industries, hotels, shops etc for insurance requirements.

3.1.3 To meet the need of the country in respect of Fire Officers, National Fire Service College, Nagpur under Ministry of Home Affairs conducts training at the levels of Sub Officers, Station Officers and Divisional Officers. The college is affiliated to Nagpur University for conduct of Bachelor of Engineering (Fire Engineering) courses.

3.1.4 India is self sufficient as far as indigenous production of fire fighting appliances, equipment and extinguishing agents are concerned. However, certain specialised hi-tech equipment and appliances are imported.

3.2 Research & Developments :

3.2.1 The Defence Institute of Fire Research, the Defence Research & Development Organisation, the Ministry of Defence, the Central Building Research Institute and the Council of Scientific & Industrial Research are the most important organizations responsible for R&D, test, evaluation & certification in the field of fire science & engineering and fire safety related matters.

3.3 Standardisation

3.3.1 The Bureau of Indian Standards (BIS) deals with the standardisation of fire safety items under the Civil Engineering Division with the responsibility of preparation of large number of Indian Standard specifications on fire fighting appliances, materials, codes of practices on fire safety matters. Government Authorities, Non-Government Organisations and Private Industries/Manufacturers are represented in various committees/sub-committees of BIS.

3.3.2 The Oil Industry Safety Directorate (OISD) formulates various standards for safety in Oil Industry under Ministry of Petroleum besides conducting safety audits.

3.3.3 Defence has its own standards & specifications.

3.3.4 Similarly some large organisations like Civil Aviation also have their own specifications. However, there is a close coordination amongst various bodies in respect with codes & standards.

3.4 Professional Institutions

3.4.1 The institute of Fire Engineers (India) is a premier professional body for dissemination of knowledge in fire safety. Its Graduate Examination is recognized by Government for recruitment purposes in various fire service organisations (Junior and middle level posts).

3.4.2 The Loss Prevention Association of India (LPA) & Tariff Advisory Committee (TAC) are General Insurance Corporation subsidiaries and are active in imparting education on loss prevention due to fire and granting insurance rebates based on suitable fire protection.

3.5 **Training Institutions**

3.5.1 The Central Industrial Security Force (CISF) has a full fledged fire training wing having trained personnel at all levels. The Fire Service Training Institute of CISF is located at Dist Tonk in Rajasthan.

3.5.2 Fire Services in Delhi, Bombay, Calcutta, Madras, Goa and other state have their own training centers for their personnel.

3.5.3 The Defence Institute of Fire Research also conducts fire fighting courses for the officers and personnel of the Armed Forces/Defence Fire Services.

3.6 **Fire Service Legislation and Acts**

3.6.1 There is no central legislation like a Fire Prevention Act in India. The National Building Code (NBC) Part IV (BIS) deals with fire safety in buildings. It is a recommendatory code.

3.6.2 Guidelines and recommendations of the standing fire advisory council, an apex body with Fire Adviser as its member secretary, Ministry of Home Affairs (DGCD-Fire Cell), are sent to State/Central departments. Fire related subjects are dealt with by the State Governments and other implementation authorities. The specifications and Codes of Practices issued by BIS are recommendatory, however, they are adopted by authorities for implementation in most cases.

3.6.3 The Oil and Mines Safety lays down provisions (Mandatory) for safety including functioning of fire officers and production of Oil in the field on land or off shore.

3.6.4 The Factory Act also lays down provisions for fire safety in industries. Petroleum Act and Environment Act 1986 are other relevant acts.

3.6.5 The Tariff Advisory Committee and the Loss Prevention Association functioning under the General Insurance Corporation of India are dealing with fire safety aspects from an Insurance angle. They are the largest and most important from the point of view of selection, adoption and installation of fire protection systems and equipment in Civil & private sector, home and industry.

3.7 **Position Regarding Implementation of the Provisions of the Montreal Protocol.**

3.7.1 Halon is a very effective fire-extinguishing agent. However, because of its high ODP, its use has to be phased out as per provisions of the Montreal Protocol without compromising with fire safety.

3.7.2 It is the Central Government who has to implement provisions resulting from its agreements under International Protocols. Therefore, considering the setup of the fire safety scenario in the country, the phase out of halons and essential use strategy should be implemented under the directives of the Central Government.

3.7.3 All the above organisations, production and users industries, fire equipment manufacturing industries, fire protection consultants and fire safety regulating bodies are important for implementing this Halon Phase out Strategy when approved. Most of these agencies, directly or indirectly, are represented in formulating this strategy.

3.8 **Production and Consumption of Fire Extinguishers, Extinguishants and Systems in the India user sector.**

3.8.1 The fire protection Industry in India can be classified in three types.

i) Only the fire extinguishing chemical production industry.

ii) Fire extinguishers and system components manufacturing industry.

iii) Fire extinguishers and system components as well as extinguishant manufacturing/production industry.

a) There are about 250 fire extinguishant, extinguisher and system manufacturing companies in India. Out of which during 1995, there were about 80 companies producing Fire

Equipment/Systems based on Halons in addition to other types. Following seven types of portable and mobile extinguishers are manufactured and used in Indian fire protection. Estimated percentage share of each of the extinguisher by type is given in Table –1 (1995).

Table 1 (1995)

i)	Halon - 1211	15%
ii)	Carbon Dioxide Wheel Valve type	10%
iii)	Water type (Soda Acid & Water CO_2)	35%
iv	Foam type (Chemical Foam)	14%
v)	Mechanical foam (AFFF) type	>1%
vi)	Dry Powder BC type (CO_2 Cartridge)	24%
vii)	Dry Powder ABC type	>1%

Soda - Acid and chemical foam type extinguishers have been declared obsolete and Indian Standards for these two are being withdrawn. The share of Soda-Acid extinguishers will be taken over by water-CO_2 or stored pressure water and the share of chemical foam by Mechanical Foam AFFF and ABC Powder Extinguisher.

(b) In order to prepare a policy and strategy for Halon phase out, it was also considered necessary to survey and prepare data on the areas of application where Halon - 1211 was being used with its share and typical sizes. This data is given in Table -2

Table - 2
Application areas & percentage share of H-1211 fire extinguishers

BEFORE CONVERSION			AFTER CONVERSION	
Field of Application	Share of total extin-guisher	Share covered by H-1211 market	Typical sizes of exting-uishers after conversion only	% share of Halon extinguisher after conversion
Private homes	5%	80%	0,5 and 1 kg	0
Shops	5%	60%	1,2 and 5 kg	0
Offices & administration	2.5%	60%	1 and 2 kg	0
Hotels	2.5%	30%	1 and 2 kg	0
Museums & heritage	3%	20%	1 and 2 kg	0
Industries & factories	15%	10%	2 and 5 kg	0
Electronics, computers	5%	90%	2 and 5 kg	2
Oil Industry	20%	15%	10 and 50 kg	0
Power Supply	10%	25%	1,2,5 and 10 kg	1
Defence equipment	12%	15%	1,2,5,10 and 50kg	2
Aviation and airplanes	5%	75%	1,2,10 &50 kg	1
Railways	10%	25%	1,2, and 5 kg	1
Cars, trucks, buses	5%	5%	0,5 and 1 kg	0

It can be seen from above table the effect of phase out action plan that all nonessential sector will stop use of Halon extinguishers. For some of the essential uses, the requirements will be 1% Railways, 1% Aviation, 2% Electronic, 2% Defence & 1% power sector.

In the following table the estimated fire extinguishing agent market in 1991 to 95 and post 2000 is shown. Two scenarios have been evaluated, one without halon like clean agent and other with clean agent.

Table - 3

Estimate of various types of portable fire extinguishers share in India before and after halon phaseout by type of extinguishers

Type of Extinguishing agent	Before Phaseout (in 1991 to 1995)	After 2000 Conventional Fire extinguishing agents only extinguishing agent	After 2000 Conventional + clean halon like fire	Comments
H-1211	15%	5%*	0 -	
Halo Carbon clean agent	0	0	10%	Not identified
CO2	10%	30%	10%	Quality / safety not acceptable to users
ABC Powder	< 1%	20%	35%	Imported/Indigenous
BC Powder	25%	10%	10%	Available
Foam	15%	15%	15%	Available
Water based	35%	20%	20%	Available
		100%	100%	100%

* About 5% Halon-1211 would be required for essential uses including servicing of existing equipment.

(c) **Halon Extinguishant Production and Consumption in India**

From early 1980, up to 1990 India imported all the three types of Halons from developed countries e.g. USA, UK, France, Germany, Japan (Halon 1211 and Halon 1301) and Halon 2402 from USSR. With the successful experience of the West in the use of Halon for fire protection, demand increased appreciably. In order to be self sufficient, Indian users (especially defence) started a programme of indigenous production of Halon 1211 and 1301 through M/s Navin Fluorine Industries and M/s SRF Ltd. Following tables 4 and 5 give the Halon production capacity and actual production and total consumption of the country.

Table - 4
Halon 1211, Production and Consumption (in ODP MT)

	1991	1992	1993	1994	1995	1996	1997
Indigenous Production Capacity	300	300	300	600	600	600	600
Production, Import & Other sources	550	266	287	237	206.4	167.6	162
Consumption in New Extinguisher (%)	85	85	85	80	75	70	60
Cons. In Servicing Old Extinguisher (%)	10	10	10	15	25	30	40
Consumption in New Systems (%)	5	5	5	5	-	-	-

Source - Recent survey conducted in the market with the major halon consumers during halon phase out project preparation.

There are two Halon 1211 Producers M/s NFI and M/s SRF. Since the demand of Halon has decreased in the Indian Market. M/s NFI stopped production in 1995. Only SRF continues to operate and produce from its plant when there is a demand.

Table - 5

Halon 1301 - Production & Consumption (in ODP MT)

	1991	1992	1993	1994	1995	1996	1997
Production Capacity	200	200	200	400	400	400	400
Production, Import & Other Sources	200	120	110	110	89.5	66.0	58.5
Old Systems Servicing (%)	10	10	10	15	25	30	40
New Systems (%)	90	90	90	85	75	70	60

*Note - Other Sources are from ship breaking industry and recovery, recycling & reclamation from old halon systems in the country.

Table – 5 bis
Combined Halon 1201 and 1301 Consumption (in ODP MT)

	1991	1992	1993	1994	1995	1996	1997
Production, Import & Other Sources	750	386	397	347	295.9	233.6	220.5

(d) Portable Halon 1211 Fire Extinguisher Production & use pattern

The Halon 1211 portable fire extinguisher market in India during 1991 to 95, was about 1/2 million per annum in different sizes, viz 500 gms to 50 kg, but major share being 500 gms and 1 kg as shown in Table 6. Total consumption of Halon 1211 for portable fire extinguisher was 550 MT in 1991 with an expected unconstrained annual growth of 10%. Therefore an estimated unconstrained demand was 1000 MT Halon 1211 in 1 million extinguishers by 1999 and 1.5 million extinguishers using 1500 MT Halon in 2005.

However, a downtrend in manufacture of Halon 1211 extinguisher began with closure of most of Aersol type extinguisher manufacturing. Out of 79 producers in 1991 - 95, there are now about 18 manufacturers with their approximate annual consumption given as Appendix F and G.

Table - 6

An overview of typical sizes with share percent of fire extinguishers identified by the Indian Fire Extinguisher standards and recommended sizes to be used by companies in conversion projects (1991-95).

H 1211 extinguisher	Share	Equivalent Clean Halon like Extinguishers Size	Equivalent CO2 Extinguishers Size	Equivalent ABC and BC Powder Extinguishers Size
0,5 kg	50%	1 kg	2 kg	1kg
1,0 kg	30%	2 kg	3 kg	2 kg
2,0 kg	10%	4 kg	5 kg	2 kg
5,0 kg	5%	10 kg	10 kg	5 kg
10,0 kg	4%	20 kg	22.5 kg**	10 kg twin trolley
50 kg	1%	Not	Not feasible	50 kg feasible

* Min. size of ABC & BC powder extinguishers are likely to be 1 Kg due to fire extinguishing rating in India.
** 50 Kg CO2 is not a replacement for its high volume, weight & mobility; hence 22.5 kg twin trolley.

(e) **Likely Halon 1211 Alternative Extinguishers**

CO_2 Extinugihser

CO_2 Fire Extinguishers in India are heavy duty MS deep drawn cylinders weighing about 4 times that of the size/capacity of Halon gas. In India high pressure cylinders fall under the legal control of Chief Controller of Explosive and light weight metal cylinders like Aluminum cylinders are not permitted at present time for filling CO_2. Hence CO_2 extinguisher has not been the choice of most of domestic/home/shop, road/rail transport and aviation sector.

CO_2 Extinguisher Production

At present there are two CO_2 cylinder manufacturers with various sizes from 2 liters to 80 liters water capacity i.e. 1.3 kg. to 53 kg. with about installed capacity of 700 (all sizes) cylinder per day. In addition because of cost factors etc. some quantities are also imported from other countries. CO_2 cylinder for fire extinguisher have also been available from other sources such as old cylinder serviced and resold etc. Table-7 shows an approximate nos. of CO_2 cylinders/extinguishers produced in India per annum.

Table 7

CO_2 Extinguisher Production (In thousand + 000)

	1991	1992	1993	1994	1995	1996	1997
Production Capacity	250	250	250	250	250	250	250
Nos. of Extinguisher Produced	150	150	100	100	75	75	100
Qty. Gas (MT)	375	375	250	250	175	175	250

Valves for CO_2 Extinguisher

At present, operation valve of CO_2 fire extinguishers are wheel valve with about 6-7 thread for opening for discharge of the gas. As a result of this slow opening valve, operating time and efficiency of Co_2 extinguisher is badly affected. Valve for CO_2 extinguisher also comes under the jurisdiction of Chief Controller of Explosives. Squeeze grip types of valve that are fast acting for high pressure gas extinguisher are not yet produced and approved by Chief Controller of explosive (CCE). This is most important factor for CO_2 extinguisher not being popular among the users in India. In advance countries only squeeze grip high pressure valves are used in Co_2 type fire extinguishers. Now approved projects have therefore asked funding & technical assistance for manufacturing of squeeze grip type valves in their proposals.

Carbon Dioxide gas for fire Fighting

Carbon dioxide gas is produced in India as a by - product in certain industries, the most important being urea fertilizer industry. CO_2 is not produced in a plant specially for fire extinguisher purposes. CO_2 from these industries is used for various other uses like soft drinks etc. CO_2 extinguisher suppliers in India do not have filling and refilling facility with them. Filling facility of CO_2 is a high pressure process and comes under the purview of the Chief Controller of Explosives. Therefore for filling and refilling, extinguisher manufacturers always depended on large industries which are normally located in big cities. Transportation cost of CO_2 cylinder therefore becomes a big incremental cost for Halon extinguisher manufacturers who plan switching to CO_2 . Industries who are switching over to this alternative have asked for financial assistance for Co_2 filling machines in their proposals.

(f) Class BC type of Dry Powder Production in India

There are about 20 manufacturers producing BC powder with 1 to 3 MT/day average production capacity. Indian Standard IS:4308 is governing standard for this powder. Only about 8 to 10 companies produce and sell this powder under IS license and quality and other are without ISI mark. There is no legislation to the effect that only IS mark powder will be produced, sold and used. At present Indian dry powder does not match the International quality and is unsuitable as substitute for Halon 1211 extinguisher specially for stored pressure type of extinguisher. Table 8 gives production/consumption of BC powder in India and Table 9 gives ABC Powder consumption figures.

Table - 8

B.C. type Powder Production/Consumption (In MT)

	1991	1992	1993	1994	1995	1996	1997
Production Capacity	2000	2000	2000	2500	3000	3000	3500
Actual Production	1000	1100	1200	1400	1600	1800	2500
Import & Export	0	0	0	0	0	0	0
Use in New Extinguisher (Percent)	75	75	75	75	75	75	75
Servicing (percent)	25	25	25	25	25	25	25

(g) ABC Type Powder Production/Consumption (INMT)

Table -9

Production	0	0	0	0
Import	100	100	200	200
New Extinguisher (percent)	100	100	100	100

Indian standard for ABC Powder is under preparation. ABC powder which is considered as one of the substitute for Halon 1211 portable extinguisher is not yet an approved product of any manufacturer in India. So far some quantities are being used for which powder at present is imported.

SECTION - 4

Selection and Adoption of Halon Alternative Technologies in India

4.1 Halon -1211 Alternatives for Portable Extinguishers are :-

1) ABC Powder extinguisher
2) $C0_2$ squeeze grip type light weight extinguisher.
3) HCFC based compounds like NAF, Halotron, FE-36 etc.

4.1.1 In order to stop production of halon 1211 extinguishers, it will be necessary for the manufacturers to switch over their production to above alternate extinguishers. The rationale for the switch-over is as below:

(a) The rationale for switching over to ABC powder extinguisher is that it will replace about 80% of portable halon extinguishers. But the difficulty before MLF assistance became available, was that ABC powder was not yet an approved product of any of the indigenous manufacturers. Furthermore, funding for technology transfer for ABC powder was not available and Halon 1211 producers were not interested in ABC powder production, as this was not in their line of products. High cost of machinery and equipment for conversion to ABC powder was also delaying the prospects. However, since MLF funding became available, all Halon extinguisher manufacturers are now keen to convert their production with technical and financial assistance. Cost effectiveness threshold of the MLF is however still of great concern.

(b) The rationale for switching over to CO_2 extinguisher is that, it can replace 20% of portable halon extinguishers, specially for electrical and electronic equipment and where damage due to water, foam and powder is not acceptable. Also $C0_2$, like halon, leaves no residue following fire extinguishing. India produced a large quantity of CO2 extinguishers (specially before introduction of halon). However, with the advent and introduction of halon extinguisher, CO2 was gradually replaced due to the supremacy of the former. To reverse the process, technology is required to make $C0_2$ extinguisher light in weight, easy to operate (squeeze grip valve operational mechanism), easy access to filling arrangement at the premises of the manufacturer as in the case of Halon 1211 and meeting International Standards.

(c) HCFC based compounds have properties by and large similar to Halon 1211. Technology for the manufacture of the extinguisher is also similar to that of Halon-1211 type. However, there is still concern about ODP, which is 0.03 for HCFC blend i.e. NAF-P4 & Halotron. Feasibility of using HCFC based extinguisher for essential uses in place of Halon -1211 will be carried out especially in view of impending production stoppage of the latter and the non-functioning of the Halon -1211 Bank in India. This work is likely to be carried out by the National Laboratories such as CSIR & DRDO.

(d) Though water mist extinguisher is being promoted in many countries in place of Halon-1211 for limited applications, technology of water mist extinguisher is still in development and evaluation stage in advanced countries. An action plan cannot be made for this replacement item at this stage in India.

4.2 Alternatives for Halon-1211 & 1301 fixed fire protection systems.

4.2.1 Indian industry has been using both Halon-1211 and Halon-1301 for fixed fire protection systems. However, more than 90% of the fixed installations employed Halon-1301 flooding systems only. Technology for production of Halon-1301 is currently available with M/s Navin Fluorine industries and M/s SRF Limited. Till date no commercial production of Halon-1301 has

taken place. The Indian industry has been totally depending on the imported Halon-1301 for its domestic consumption.

4.2.2. Drop-in replacement for Halon-1301 is still not available anywhere in the world. Having regard to this fact, most of the applications using Halon-1301 can be met by conventional systems and to a lesser extent by chemical substitutes. Based on the decision of the fire protection industry and the users, feasibility of adopting the chemical and non-chemical alternatives mentioned below are proposed in this strategy document.

4.2.3 The following technologies have been imported for evaluation, demonstration and adoption under Indian conditions at Defence Institute of Fire Research under the Montreal Protocol funded project :

a) CO2 fire extinguishing in cabinet and sub-floor systems. At present CO2 fire extinguishing system for unoccupied spaces (total flooding type) is available in India. In cabinet sub-floor system is no different. There is urgent need for standards, codes and approvals to be prepared by BIS under MLF funded project. The details of funds required given in Table -11.

b) Inert gas extinguishing systems (Nitrogen based). Consisting of Inergen and Argonite based inert gaseous systems.

c) Water mist fire extinguishing system. Consisting of High, Medium and Low pressure, and also single and dual pipe systems.

d) Fast response sprinkler system

e) ABC powder extinguishing systems

4.3 The Halon Technical Options Committee (HTOC) report identified the factors to be considered while selecting, evaluating alternatives and finding chemical substitutes. Accordingly, chemical substitutes are being identified for use in India after using them in the following criteria :

a) Life cycle and environmental impact of the chemical extinguishant i.e. ozone depletion potential, global warming potential and atmospheric life time should be acceptable under International treaties.

b) Fire suppression effectiveness of the system as a whole i.e. design concentration, clean extinguishing characteristics, rapid knockdown of fire and discharge time;

c) Risk to health and safety for the occupants i.e. toxicity of the agents used. The No Observed Adverse Effect Level (NOAEL) and the Lowest Observed Adverse Effect Level (LOAEL), decomposition of products following extinguishing and tolerance of humans in the vicinity of discharge are to be taken into account;

d) Cost effectiveness of the agent and system as a whole i.e. initial cost, running cost, retrofitting capabilities etc.

e) Space constraints for the system i.e. for compact and long term storage of the cylinders, technical possibility to keep the cylinder away from the protected area etc.

f) Physical and chemical properties of the agent i.e. electrical conductivity, suitability for inerting application, light obscuration, temperature reduction and pressure fluctuation during discharge, tolerance to equipment in the vicinity of discharge, corrosion etc.

g) Other important considerations i.e. availability of test reports from recognized laboratories, multiple sources of availability of the agent and also important hardware for the system in the neighbourhood, availability of national and international standards for the design and installation of the system etc.

h) Recommendations made at the Kyoto conference regarding phaseout of certain greenhouse gases including CO2, HFC and PFCs.

4.4 Based on the above criteria, substitutes identified/evaluated in industrialized countries are given as under. These substitutes/ alternatives are generally found to be application specific

i.e. occupied & unoccupied areas applications, corrosion of delicate machinery equipment, availability for refill within specified period of time etc. Therefore, the choice of one of these substitutes alternatives is left to the fire protection consultants & users of a particulars premises.

HALOCARBONS

HFC-227 ea (FM-200)
HFC 23 (FE-13)
HCFC Blend (NAF-SIII)
FIC-1311 Triodide

INERTGASES

Nitrogen: IG-10 (N_2)
Inergen: IG-541 (N_2, Ar & CO_2)
Argonite: IG-55(N_2 & Ar)
Argotec: IG-01 (Ar)

WATER MIST (low & high pressure)

4.5 Halocarbon (Chemical Gaseous) Agents

4.5.1 FM-200, HFC-227 ea (Heptafluoro propane - CF3CHFCF3)

4.5.1.1 General

- Product of U.S. based GLCC company, the only manufacturer of FM-200, probably worldwide patented. Outlets through few agencies in India.
- No ODP, Appreciable GWP and low atmospheric life time.
- Less efficient than Halon-1301 in extinguishing efficacy.
- Needs about 60% more agent than Halon-1301 and this means more cylinders, change in pipe size, valves, discharge nozzles and design philosophy.
- Cylinder pressure for 25 and 42 bars system as in Halon-1301.
- Clean, vaporizing and non-conducting gas like Halon-1301.
- Minimum design concentration is about 8.5%. Lowest observed toxic level is at 10.5%.
- Discharge time 10 seconds.
- Available standard specification in NFPA 2001: 1998

4.5.1.2. Compatibility

- Neither a drop-in replacement nor a Retrofit type alternative system.
- Hydraulic calculations are totally different from that of Halon-1301 though the operating pressures are same.
- 60% more by weight and 40% more by volume compared to those of Halon-1301.

4.5.1.3 Acceptability

- Acceptable alternative agent for fire suppression for normally occupied areas.
- Specified alternative in NFPA-2001.
- Acceptance subject to conditions by approval of Underwriters Laboratory (UL) Factory Mutual Research Corporation (FMRC) both USA, Loss Prevention Concil (LPC), UK etc.
- Decomposition products in the form of HF which is toxic to humans and corrosive to equipment within the protected enclosure.

- NFPA-2001 mention that FM-200, where design concentration is greater than NOAEL ie 9%, shall not be permitted for use in normally occupied areas. For class B hazards and where acceptable to authorities having jurisdiction concentration up to 10.4% shall be permitted in normally occupied area where pre-discharge alarm and time delay provided.
- Agent specified in draft Kyoto protocol as global warmer.

4.5.1.4 Availability

- Only manufacturer of the agent and also design and supply of the system including hardware will be by GLCC. Hence total import dependency.
- Filling and Refilling facilities reported to be available in India with few suppliers.
- The local suppliers have been given rights to supply FM-200 systems with UL/FMRC etc. approved design.

4.5.2 NAF - SIII [HCFC Blend] : A blend of

HCFC 22	=	82.00%	(CHCLF2)
HCFC 123	=	04.75%	(CHCl2CF3)
HCFC 124	=	09.50%	(CHClFCF3)
Detoxifying agent	=	03.75%	

4.5.2.1 General

- Product of Canada and Italy based North American Fire Guardian Technology company, appears to be the only manufacturer, probably worldwide patented. Outlets through few agencies in India.
- ODP of 0.036, low GWP and a very low atmospheric life time. Due to ODP, the agent needs to be phased out by the year 2040 as per Montreal Protocol.
- Less efficient than Halon-1301 in extinguishing efficacy.
- Needs about 10% more agent than Halon-1301 and this means (as per the manufacturer) the system is near identical, same cylinders pipe size, valves etc. could be used, slight modifications in discharge nozzles and design philosophy. In other words, retrofitting of the existing Halon-1301 systems can be done with NAF-SIII agent. This requires a check from case to case.
- Cylinder pressure for 25 and 42 bars system as in Halon-1301.
- Clean, vaporizing and non-conducting gas like Halon-1301.
- Minimum design concentration for class 'A' fire is 8.6% and class 'B' fire 11.9% and lowest observed toxic level is at 12%.
- Discharge time 10 seconds.
- Standard design specification is available in NFPA-2001-1998.

4.5.2.2 Compatibility

- Not a drop-in replacement but reported to be Retrofit type alternative system. The retrofitting requires to be verified by the users on a case to case basis and it cannot be straightly called as a retrofit system in all cases.
- Hydraulic calculations are totally different from that of Halon-1301 though the operating pressures are same.
- 10% more by weight (no change in volume) compared to those of Halon-1301.

4.5.2.3 Acceptability

- Acceptable alternative agent for fire suppression for normally occupied areas.
- Specified alternative in NFPA-2001.
- No known approvals from agencies like UL/FMRS listed by UL Canada.

- Decomposition products in the form of HF which is toxic to humans and corrosive to equipment within the protected enclosure.
- Not encouraged in European countries due to small Ozone Depetion Potential of 0.036.

4.5.2.4. Availability

- North American Fire Guardian, Italy appears to be - only manufacturer of the system and also design and supply of the system and hardware for new systems will be by them. Hence total import dependency.
- Filling and refilling facilities reported to be available in India.
- Major chemical in the blend i.e. HCFC-22 (82%)is produced in India, therefore there is likely the blend will be manufactured in India at a later stage if demand grows.

4.5.3 FE - 13 (HFC-23), Trifluoromethane (CHF3)

4.5.3.1 General

- Product of USA based Dupont company. Appears to be produced in India by M/s SRF, Delhi as claimed by the company.
- Zero ODP, high GWP and atmospheric life time. Due to high GWP, the agent is avoided by several users despite being a non-controlled substance under Montreal Protocol.
- Less efficient than Halon-1301 in extinguishing efficacy.
- Needs about 60% more agent than Halon-1301 by weight and 150% by volume. Hence neither a drop-in nor retrofitting agent for Halon-1301.
- Cylinder pressure quite high i.e. 52 bars. No nitrogen super-pressurization required.
- Clean, very low boiling point, vaporizing and non-conducting gas like Halon-1301.
- Minimum design concentration is about 16% and lowest observed toxic level is at 50%.
- Discharge time 10 seconds.

4.5.3.2 Compatibility

- Neither a drop-in replacement nor a retrofit type alternative system.
- Hydraulic calculations are totally different from that of Halon-1301.
- Cylinder and pipe-sizes require special design owing to the high pressure requirement.

4.5.3.3 Acceptability

- Acceptable alternative agent for fire suppression for normally occupied areas and have approval of UL, FM.
- Specified alternative in NFPA-2001.
- Decomposition products in the form of HF which is toxic to humans and corrosive to equipment within the protected enclosure.
- Agent specified in draft Kyoto protocol (global warmer) and might come under climatic change treaty in future.

4.5.3.4 Availability

- Du Pont USA is manufacturer of the agent and also design and supply of the system including hardware will be by them. M/s SRF Ltd. New Delhi claims to have commercial production but system design and hardware are to be imported.
- Filling and Refilling facilities - no information

4.5.4. Triodide (Trifluoromethyliodide, CF_3I)

4.5.4.1 General

- Manufactured by Pacific Scientific Co. USA.
- No ODP, negligible GWP and negligible atmospheric life time.
- More efficient than Halon-1301 in extinguishing efficacy.
- Clean, vaporizing and non-conducting gas like Halon-1301.
- Minimum design concentration is about 3.6% and lowest observed toxic level is at 0.4%. The toxic level is the greatest disadvantage. High risk of cardiac sensitization.
- Discharge time 10 seconds.

4.5.4.2 Compatibility
- Neither a drop-in replacement nor a Retrofit type alternative system.
- Hydraulic calculations are totally different from that of Halon-1301.

4.5.4.3 Acceptability
- Acceptable alternative agent for fire suppression only for unoccupied areas such as aircraft engine nacelles.
- Specified alternative in NFPA-2001.
- Decomposition products in the form of HI which is toxic to humans and corrosive to equipment within the protected enclosure.
- No known approvals from agencies like UL/FM and LPC etc.

4.5.4.4 Only manufacturer of the agent and also design and supply of the system including hardware will be by Pacific Scientific Co. USA. Hence total import dependency.
- Filling and Refilling facilities - no information.

4.6 **Inert gas extinguishing systems**

4.6.1 General

There are four systems i.e.,

1. Nitrogen N_2-100%;
2. Inergen - a mixture of N_2-52%, Argon-40% and CO_2-8% (a product of Wormald and Ansul USA);
3. Argonite - Argon-50% and N_2-50% (a product of Ginge Kerr, Denmark)
4. Argotec - Argon-100% (a product of Minimax, Germany)

Characteristics:
- No ODP, No GWP and not controlled under any climatic convention.
- Less efficient than Halon-1301 in extinguishing efficacy.
- Extinguish fires by reducing oxygen levels within the the protected enclosure between 12 to 14% at which combustion process is not sustained.
- Needs about 500% more agent than Halon-1301 by weight and volume and this means more cylinders, more space requirement, change in pipe size, valves, discharge nozzles and design philosophy.
- Cylinder pressure for 150 to 200 bars system and pressure reduced upto 8 to 10 bars by devices near the manifold.
- Clean, and non-conducting Natural gases.
- Minimum design concentration is about 35% and lowerst observed toxic level is at about 52%.
- Discharge time not to exceed 60 seconds during which 95% of the discharge concentration is achieved.

4.6.2 Compatibility

- Neither a drop -in replacement nor a Retrofit type alternative system.
- Hydraulic calculations are totally different from that of Halon-1301.
- 500% more by weight and volume compared to those of Halon-1301.

4.6.3 Acceptability

- NFPA (USA) Acceptance for exposure - No inert gas agent with design concentration above 43% which corresponds to an oxygen concentration of 12% shall be permitted for use in normally occupied areas.
- Otherwise acceptable alternative agent for fire suppression for normally ocupied areas.
- specified alternative in NFPA-2001.
- Acceptance subject to conditions by SNAP, EPA (USA), LPC (UK), UL & FM.
- No decomposition products either toxic to humans or corrosive to equipment within the protected enclosure.
- Difficult to install in locations where space and weight of cylinders are constraints. Possible to install cylinders as far as 150M away from the protected enclosure.

4.6.4 Availability

- Being naturally occurring gases, availability of the agent is not a problem. also the process of filling and refilling are simple. However, some agents each as inergon are required to be blended only by authorized supplier.
- Filling and Refilling facilities reported to be available in north & western India with few suppliers.
- Servicing of the system is simple and is possible to develop in different parts of the country.

4.7 **Water Mist System**.

4.7.1 General

- Water in the form of fine droplets (20 to 500 microns) when discharged inside an enclosure, diffuses like a gas and act as a three dimensional extinguishing agent.
- Uses a little amount of water compared to conventional sprinkler system and thus secondary damage is significantly reduced.,
- Not controlled under any of the climatic convention.

There are several types of water mist technologies available in the world. Three commonly employed water mist systems are as follows:

a) High pressure water mist system (100 bars)
b) Low pressure single fluid water mist system (12 bars)
c) Low pressure twin fluid water mist system (10 to 12 bars)

4.7.2 Compatibility

- Other than specially designed nozzles, the system has the advantages of very low cost, eco-friendly, non-toxic etc.
- Neither a drop-in replacement nor a Retrofit type alternative system due to the different extinguishing mechanism.
- Different hydraulic considerations for water based systems and hence the piping and nozzle design are also totally different.

4.7.3 Acceptability

- Specified in NFPA-750. Design requirement, Calculations etc. for system acceptance are specified in detail in the above standard.
- Acceptance subject to conditions by Safety of Life at Sea (Regulations for Marine) SOLAS for marine application.
- NO decomposition products either toxic to humans or corrosive to equipment within the protected enclosure. However it is necessary to use potable water for water mist system in occupied areas.

4.7.4 Availability

Manufactured abroad. Design and supply of the system including hardware will be by importation. Hence total import dependency at present.

4.8 CONCLUSIONS

4.8.1 India has to use Halons for essential uses until equivalent substitutes with new design systems are made available. However, such uses only represent a small percentage of total use.

4.8.2 For portable extinguishers the following substitutes are considered suitable for adoption in India.

a) ABC Powder extinguisher,
b) CO_2 extinguisher (preferably squeeze grip, light weight type);
c) HCF/HFC based extinguisher such as NAF-P4, Halotron, FE-36 etc. (Limited to specialised application in absence of H-1211).

4.8.3 For other uses based on various factors specified in paragraph 4.3, the following alternatives are considered suitable for adoption in India:

a) FM-200 (HFC - 227 ea)
b) NAF-SIII (HCFC Blend)
c) FE-13 (HFC-23)
d) Inertgases systems
e) Water mist systems (low pressure)
f) CO_2 in-cabinet and sub-floor systems.

4.8.4 A careful analysis of the risk, judicious choice of the appropriate risk matching agent with suitable system design involving consideration i.e. cost, space, weight, availability of supply and serviceability is required by users and fire protection consultants for their selection.

4.8.5 At present, no other chemical substitutes of halons are being considered for use in this strategy, and any new agent as and when evaluated and found to meet set criteria will be considered.

Section - 5

Halon Management and Banking Programme

5.1 Major users are gradually reducing use of Halon-1211 portable extinguisher except for certain essential uses. Servicing of old extinguishers however is continuing with newly produced Halon, as there is no facility so far available in the country for recovery and recycling of halon from existing extinguishers. Service life of mobile and portable extinguisher is expected to be about 10/15 years and during this time they will need to be refilled.

5.2 Similarly most of large and small users of Halon-1301 system have more or less stopped installation of new Halon-1301 system except for certain critical and essential applications. However, all the users in India are totally dependant on refilling and servicing of existing Halon-1301 system with recycled/reclaimed gas as these installed system are expected to continue till their service life or life of the protected equipment facility.

5.3 It has been proven beyond doubt that, the alternatives which are identified at present are not - drop in substitutes.

5.4 Therefore the users having large installed H-1301 quantities and others having critical application are planning Halon Management and Banking Programme within their organisation such as Defence, Oil and Natural Gas Corporation and National Thermal Power Corporation.

5.5 These organisations with technical and partially financial support from MLF have following plans to conduct.

5.5.1 Study to reduce the risk of accidental discharge of Halon systems i.e. conservation related work. Most of the systems are automatic and due to an accidental discharge, a large quantity of Halon can be released to the atmosphere which can be prevented in many ways. (Which the Organisation follow regularly through their maintenance schedules). It is believed that as the system grows older, preventing such discharges would become difficult. It is therefore planned to examine the need for Halon-1301 systems to be in automatic or manual and where it is not considered necessary they can be placed on manual operation only, thereby reducing the risk of accidental discharge.

5.5.2 Testing of the system/installation

5.5.2.1 Because of high cost of Halon gas, there was no normal practice to conduct the discharge test. Still for initial and some critical areas, such tests were conducted as per guidance of suppliers. As the systems are getting older, it is important to test their performance. It is understood that systems will be tested for their performance, using alternative gases and by pressure testing of the piping and nozzles etc. As integrity of the protected area in terms of leakage is an important requirement of gaseous agents like Halon, it is necessary to develop such tests/inspection procedures and training to the users that do not discharge the gas.

5.5.3 Recovery and Recycling of Existing Halon

5.5.3.1 Defence and Civil Sector major users such as NTPC, ONGC, Army, Navy & Air Force etc are maintaining Halon-1301 in their various existing systems. The gas in these systems may be up to 10 years old. There are three important aspects of their stocks :

(a) The quality of the gas during long storage.
(b) The performance of the cylinder and system piping, as a whole under high pressure.
(c) Development of facilities for recovery, recycling and reclamation of H-1301 gas from the existing systems, and putting it back after system tests.

5.5.3.2 A procedure has to be developed for this work and training imparted to the engineers and staff handling this stock.

5.5.3.3 It is considered necessary for above mentioned major users to start work in the following lines partly with their own resource and partly MLF supported :-

- Study the health of Halon system.
- Training to the people for this change.
- Study and development of test method for existing Halon system.
- Recovery and recycling equipment for Halon 1301 and training.
- Start up of Halon recycling center.
- Training to trainer on risk analysis to negate the future needs of Halon system for non critical applications.

Section - 6
Halon Essential Use Panel
Terms of reference and constitution

6.1 Introduction

6.1.1 Halon Essential Use Panel (HEUP) is to be established as advisory panel to Ozone Cell, Ministry of Environment and Forest for granting exemption for use of Halon-1301 for fixed fire protection and Halon-1211, for fixed and portable extinguisher' in India after legislation is brought out by MOEF for limiting use of Halons to only essential uses where other environment friendly agents are not suitable.

6.2 Criteria

6.2.1 The basic definition of halon `essential uses' will be taken from UNEP document (HTOC report) and will be expanded keeping in view, Indian conditions and International practices

6.3 Duties

6.3.1 The panel will examine, analyze and consider the application for essential use status based on criteria for following work :-

- The installation of new halon 1211 extinguishers and reallocation of existing portable extinguishers.
- Refilling of existing portable extinguishers.
- Installation of new fixed halon 1211 and halon 1301 system
- Refilling of old halon 1211 and 1301 system.

6.3.2 The panel will recommend essential use for a specific period of time, with the condition that submissions include a report as to what measures are being taken for future permanent phase-out and what actions are being taken to avoid discharges of Halon.

6.3.3 The panel will advise the Ozone Cell to accept or reject the application for Import and Export of Halon based equipment and systems on `Essential Use' criteria in consultation with DGFT.

6.4 Authority - Ozone Cell, MOEF

The panel will act as an advisory body to the Ozone Cell, MOEF. It can give recommendations only which may be accepted or rejected by the Ozone Cell. It would not have any executive power.

6.5 Constitution

6.5.1 The panel will be a group of experts. It will have two members and one Chairman. The members and Chairman will be recommend by HAOC to Ozone Cell, MOEF, who will be the approving body.

6.5.2 The tenure of the panel will be for 2 years initially and extended up to 5 years the Chairman will be rotating every year among the members. The members also will be changed by :

- Resignation
- Termination of members by Ozone Cell

6.6 Procedure

6.6.1 Users, supplier, consultant or organisations asking for essential use of Halons will submit their applications to Director, Ozone Cell, Ministry of Environment and Forest, on the prescribed proforma. Ozone cell on the merit of application will forward this application to chairman of the panel. This process will be completed in 10 days time and the panel's reply to MOEF will be sent in another 10 days.

6.6.2 Depending on possibility of meeting or otherwise, the Chairman will circulate the applications and get the opinion of the panel members so that the whole process of granting or rejecting the application will be completed in 30 days. Rejected applications can be resubmitted for review but with valid reasons but will essentially follow the same route for approval.

6.7 Funding and Administrative Support

The Ozone Cell, Ministry of Environment and Forest will support the panel. However, a project to meet the expenses of the panel will be put up by the ozone cell. The approximate funds required for this activity are as given Table - 11

6.8 Essential/ Critical Applications

Some of the essential uses identified by working group HAOC for which no alternatives are available are as given below:

1. Servicing of existing equipment systems where retrofit/ drop in substitute is technically & economically not feasible. Such systems will utilize halons till the service life of the protected equipment.

2. Other Critical, applications such as :
   - Shipboard total flooding applications
   - Aircraft fire protection land portable extinguisher for cabin & explosion suppression system for engine.
   - Flight line fire protection
   - Air crash fire & rescue vehicles
   - Fire & explosion suppression
   - Other critical applications are still being identified by the Committees and will be put up to the panel.

SECTION - 7
Action Plan for Halon Phaseout Program in India.

7.1 India's Halon phaseout action plan is given in Table-10 which includes proposed activities, and also elaborates on responsibilities of likely agency/agencies for implementation of the plan.

7.1.1 The second part of the chapter deals with the Halon Alternative Project funding and implementation. Certain important projects identified that need MLF funds to meet the target are given in table - 11.

7.2 Action Plan cover following activities

7.2.1 Ozone Layer Protection Awareness was started in 1991 and would continue till 2002 and beyond (need based). Already three international seminars have been conducted in 1991, 1994 and 1997, where over 15 speakers presented papers on National / International scenario of ozone hole, ozone layer protection, and halon alternative technologies. Two of these conferences were partly supported by MLF funded project and other by MOEF and USEPA. Five National Seminars on Halon-Ozone and alternative technologies conducted during 95 to 97 assisted by MLF funded project. About 50 presentations were made by various members of Halon Alternative Option Committee (HAOC), UNEP HTOC members and Halon user organisation in various seminars and workshops throughout the country.

7.2.2 Halon alternative technologies have been installed at DIFR Delhi for demonstration and evaluation to fire protection community including users, manufacturing industry, consultants, legislative and insurance authorities etc. Over 600 persons visited the halon alternative laboratory till 1997. This Programme is continuing which is partly funded by MLF, industry and government and expected to continue up to 2002.

7.3 Portable Halon 1211 extinguisher and 1301 system conversion.

7.3.1 A Project proposal was submitted by the largest Halon extinguisher manufacturing company in 1994. The Company had planned to phase out use of 150 M.T. Halon-1211 per annum under this project. Project was approved for MLF funding in 1996. About 200 MT Halon was phased out by way of stopping Aerosol type Halon 1211 extinguisher by this company & other SSI companies in India by that time.

7.3.2 Seven projects, 5 for conversion of portable H-1211 to CO_2 and ABC powder and Halon-1301 to FM-200, NAF-SIII, Inert gases and two projects for conversion of Halon 1211 to CO_2 & ABC Powder have been approved in March 1998 at the cost of US $ 940,000 by Executive Committee of Multilateral Fund. These projects are under implementation. These seven companies will phase out 840 ODP tonnes of Halon at US $ 940,000 which is below the threshold of 1.48 US $/kg ODP set by the MLF for the Halon Sector.

7.3.3 Seven leading industries, one in Chennai, three in Mumbai, one at Baroda and two in Delhi will implement their project during 1998-2000 and will phase out 75% Halon-1211 use in India.

7.3.4 The cost effectiveness threshold is not sufficient to implement the projects by the industry. However, because of the voluntary action and future effect on fire safety etc., Indian industry has agreed to take up this task and half the cost is being borne by them.

7.3.5 Main agencies responsible for this work are UNDP and UNOPS as implementing agency, Ozone Cell, MOEF, Government of India and Fire Protection industry whose projects are approved.

7.3.6 Six more similar projects are to be put up in 1999 for MLF funding. They include investment projects of six fire extinguisher & system companies.

7.3.7 Halon gas producers are likely to put up the project for funding their closure in 1999.

7.4 **Education and Training**

7.4.1 In addition to investment projects, it will be necessary to undertake training project for continuation of awareness on Halon alternatives and related activities. (Annexure IV) :-

i) Formation of Halon Essential use Panel. -Ministry of Environment & Forest, Ozone Cell is responsible for all legislative and administrative activities which needs to form a panel of experts for the purpose. Ozone cell will require funding for this from MLF. Terms of Reference & constitution on Halon Essential use Panel has been elaborated in Section 6 of this report and funding in Table - 11.
ii) Revision, addition and preparation of new Indian standards, codes & manuals etc.

Standards are key to the success for the implementation of the halon alternative technology and phase out programme. A sub Committee has been formulated by BIS for preparation of a project funded by MLF for revision of existing standards and preparation of new Indian standards pertaining to Halon alternatives/ substitutes In its first meeting held on 13 Aug. 1998, following programme of work was considered and for which a project proposal will be prepared on the following subjects:

- New Code of Practice on Halon Extinguisher use, servicing etc.
- Revision of all IS, Defence, TAC, OISD, CEA, MMD standards at present specifying Halon under different forms.
- Revision of National Building Code.
- New Standard preparation on FM 200 and NAF SIII etc. fire extinguishing agent and fire protection system.
- New Standards on inert gaseous extinguishant and design of fire protection system and standard for water mist fire protection system.
- Standard on new design Co2 portable and trolley mounted squeeze grip type operation and approval from C.C.E. for new designs.
- Establishment of National facility/laboratory for test, evaluation, certification of the new generation fire protection Halon alternative systems.

In normal cases revision of standards in India takes 2 to 5 years and whole process takes about one year for minor modifications. New standard preparation and adoptation generally is very lengthy process may take over five year. This is due to non availability of funding for experts and committee member who have to attend meetings and have to come from different part of the country.

7.5 **Halon management and Banking** - Recovery, recycling and reclamation facilities need to be set up. These activities are explained in Section-5.

7.6 **Legislative and Administrative Controls on Halon Consumption**.

6.6.1 Certain incentives, disincentives, controls, directives on ozone depleting substances Regulations / Rules will be in place. The key factors for success of halon phase out programme of the country are as under:-

a) No Financial Institution will finance projects that make use of ozone depleting substances.
b) No customs and excise duties will be levied on the capital equipment that are required for manufacture of ODS free alternative equipment for MLF approved projects. A letter from MOEF is placed at Annexure I.
c) ECO - mark criteria for fire extinguishers with non ODS, have been notified by the Central Pollution Control Board (CPCB) - Annexure II).
d) Halons have been put under the restricted list of import and export.
e) Revision of codes for fire protection for Industry and building and preparation of new standards, codes on halon alternative technologies (Bureau of Indian standards).
f) Premium for insurance on using halon alternatives (Tariff Advisory Committee letter - Annexure III).
g) Circulars/ directives on promoting halon alternatives (Fire Advisor, Ministry of Home Affairs).
h) Enforcement of Environment (Protection) Act, 1986 with respect to ozone depleting substances including halons. The draft regulation is in circulation. The various provision in the act/regulation defined are:-
    i) Manufacture of Fire Extinguisher or Fire Extinguishing system based on halon will stop on 1.1.2001.
    ii) Prohibition on export and import of ODS from countries not specified in Article-5.
    iii) ODS can be exported to Article-5 (i) countries only under a license.
    iv) Regulation on the sale, purchase and use of ODS including halons.
    v) Prohibition on new investment with ozone depleting substance
    vi) Regulation on import, export, and sale of products made with or containing ozone depleting substances.
    vii) Monitoring and reporting requirement of above rules and regulations.

TABLE – 10 -- **HALON PHASEOUT ACTION PLAN YEARWISE**

ACTIVITIES		91	92	93	94	95	96	97	98	99	00	01	02	Agency Responsible
1. Ozone Layer Protection awareness, seminars conferences etc.														MOEF Supported by MLF, NGO etc.
2. Halon Alternative, Education, Demonstration														MOEF, DIFR, MLF Support.
3. Halon Extinguisher Conversion to CO_2 /ABC														Fire Protection Industry, MOEF with MLF support
4. Halon System Conversion to FM-200 NAF-S III, Inertgas Water Mist.														Fire Protection Industry, MOEF with MLF support
5. Closure of Halon Production														Industry/MOEF with MLF support
6. ABC Powder Production														Industry
7. Revision of Standard and Codes														BIS, Industry and users with MLF support
8. Preparation of New Codes and Standards for Halon Alternative														BIS, Industry and users with MLF support
9. Formation of Essentiality use panel														MOEF-MLF support
10. Legislation to ban New Halon Systems Except for essential use)														MOEF and Fire Advisor
11. Legislation on ban on prod. Of new Halon Extinguishers														MOEF
12. Legislation to ban Import & Exp. Halon base Equipment / System														MOEF
13. Halon Banking and Management for essential uses in Place														Private Sector Users, MOEF with MLF support
Effect of above action on Halon Consumption	H-1211	**550**	**266**	**287**	**237**	**206**	**168**	**162**	**75**	**75**	**50**	**25**	**15**	
	H-1301	**200**	**120**	**110**	**110**	**90**	**66**	**59**	**50**	**25**	**10**	**5**	**5**	

Table - 11

Incremental Cost Calculated for India's Halon phase out projects

To assit industry to step up the Halon phase out programme and authorities to implement programmes to meet the Montreal Protocol obligations as per this Halon Phase out strategy and country program deadlines, following projects will be taken up with the financial support from Multilateral Fund of Montreal Protocol.

	Project Description	**Funds * in US $** (approximately)	**Time Period**
H-1	Setting up of the Halons Essential Use Panel	150,000	1999 - 2005
H-2	Conversion of Halon Portable extinguisher and Fixed Systems to alternative ODS free extinguishers (About 15 industries).	1,400,000	1998 - 2000
H-3	Preparation & revision of codes & standards to ISO level & their circulation (about 50 standards)	50,000	1998 - 2000
H-4	Project for Halon producers for enforced idleness/conversion/closure	2,500,000	1998 - 2000
H-5	National Halon Banking Programme	500,000	1999 - 2005
H-6	Education Training Programme awareness	500,000	1998 - 2005
	Total	**5,100,000**	

* The above figures are rough estimates and detailed actual costing would be done when the projects are formulated by the concerned implementing agencies.

APPENDIX A

Halon Phaseout Programmes in Some Other Countries -

The Montreal Protocol on Substances that Deplete the Ozone Layer is a global treaty and problems of ODS are being solved globally. The principle of this strategy is that no country can solve the entire phase out problem in isolation. Therefore, while formulating this strategy, for reference, strategies of some other countries have been studied. Brief of strategies of some of these countries are given as under. The information, as far as known, for countries like United States, United Kingdom, Australia, European Union, South Africa, Japan etc. have been studied and given for the benefit of Indian fire protection community.

The general trend has been that countries with smaller Halon consumption have a very progressive phase out schedule, while others with large uses of Halon have a slower phase out programme. Among the Article 5 countries China is the largest producer and consumer of Halon, and has a phase out programme in place.

In the Montreal Protocol, the consumption of CFCs and Halons is defined as production plus import minus export. Consumption takes place when Halon is produced or imported for the production of Halon fire extinguishing equipment, when Halon fire equipment is imported and to maintain and refill existing Halon equipment.

When the Parties of the Montreal Protocol in November 1992 decided that production of new Halons in non Article 5 countries should stop by Dec 1993, it was estimated that the need for new Halons was limited, and recovered Halons from existing non critical uses can cover the demand for Halons for existing Halon equipment for their remaining lifetime. In order to implement the decisions of the Parties, the different countries have taken different actions and strategies as given below :

USA

USA has been the main user of Halons with an annual consumption of 40% of the total Halon consumption in the World. Production of Halons was stopped by regulation from Ist January 1994 in USA. No restriction exists however in USA on the use of Halons for new installations or production of portable Halon fire extinguishers, nor have any deadline been set for stoppage of Halons, except that high taxes have been imposed on Halons since 1990. The tax also covers imported recycled and reclaimed Halons meeting ISO quality standards. The tax is presently 100 to 200%. As the production stopped in Jan. 94, the fire protection industry has stopped the production of Halon fire extinguishers and installation of new Halon fire extinguishing systems, except for a few areas considered essential. The supply of Halons for servicing of existing Halon fire fighting equipment is based on recycling for which a strong market exists. In order to assist users, a Halon Clearing House was set up with financial support from USEPA, users and the industry. Recycling and reclamation centers have been set up by private companies and some larger and critical users of Halons have worked out the phaseout plans and/or set up their own Halon banks, eg, NASA, Deptt. of Defence and Aviation etc.

In order to limit emission of Halons, the Clean Air Act of USA requires that recycling equipment is used by all Halon servicing, refilling and transfer stations. USA has adopted alternatives like FM-200, NAFS-III, PFC's, Inert gases, dry powder, water mist etc. for fixed total

flooding systems, and ABC powder, CO2, HCFC & PFC for portable hand extinguishers, USA does not allow Import & Export of Halons & Halon based fire protection in their country.

AUSTRALIA

In order to avoid emission of Halons, no refilling is allowed in Australia since 1992. Also, import of Halons for new installations have been completely banned. All the uses of Halons have been replaced by other alternatives since 1996. Australia is the first country, to have started decommissioning of Halon systems and portable extinguishers from active use. Australia has begun one of the largest Halon banking and recycling facility. Australia has regulation in place not to allow Import and Export of Halons and Halon based equipment.

Australia is also first country to establish Halon essentially use panel in 1990 for new Halon equipment and consumption was dramatically reduced and eliminated import of any halon by 1993.

Australia used NAF-SIII, FM-200 and to limited scale, FE-13. FE-25 and Inergen. Australia also is among few countries to have established the CFC and halon destruction facility with the support of commonwealth government. Australian concept for reducing dependence on halon based equipment is well perceived. The design of new installation should incorporate precautionary measures such as improving building materials, and interior design to reduce fire ignition and spread, isolation of sensitive electronic equipment, early warning detection devices etc.

European Union Regulation on Ozone Depleting Substances

An EU Directive on CFC and Halon production and import of Halons was issued in 1992. The Directive controls production and import of CFCs and Halons in the member states. EU has brought out the following regulations in January 99 :-

- HCFC production to be phased out by 2025.
- General ban on the supply and use of all controlled substances except HCFCs & methyl bromide. Halon use ban deferred until 31 December 2002 for existing fire protection systems with mandatory decommissioning a year later. Ban does not apply to critical uses of halon.
- Use of HCFCs as fire fighting agents to be permitted in very limited circumstances.
- Ban on export of controller substances (except methyl bromide & HCFCs) and products and equipment containing them.
- Introduction of an export authorisation regime.
- Mandatory recovery of used controlled substance contained in refrigeration and air conditioning equipment (from 2002 for domestic freezes & freezers), equipment containing solvents, fire protection systems & fire extinguishers.

Critical uses of Halon as identified by European Union are as given under :-

Use of Halon 1301 :

- In aircraft for the protection of crew compartments, engine nacelles, cargo bays and dry bays.
- In spaces occupied by personnel and engine compartments of military land vehicles and marine vessels.
- For the making inert of occupied spaces where flammable liquid and/ or gas release could occur in the military and petrochemical sector and in cargo ships.

- For the making inert of manned communication and command centres of the Defence forces or otherwise essential for country governments and security existing at (date).
- For the making inert of spaces where there may be a risk of dispersion of radioactive matter.
- In the Channel tunnel and associated installations and rolling stock.

Use of Halon 1211 :

- In hand-held fire extinguishers and fixed extinguisher equipment for engines for use on board aircraft.
- In aircraft for the protection of crew compartments, engine nacelles, cargo bays and dry bays.
- In fire extinguishers essential to personal safety for initial extinguishing by fire brigades.
- In military and police fire extinguishers for use on persons.

South Africa

South Africa has set up its own Halon bank consisting of a clearing house and a network of fire equipment companies who can recover and recycle Halon. The South African Halon bank serves other countries in the region as well.

Japan

Production of Halon and Halon based equipment ceased during Dec. 1993, Japan has Halon Bank for their critical uses and also has set up a Halon recycling programme. Japan is adopting alternatives like FM-200, ABC powder and mist technology. Japan has set up Halon Recycling and Banking Support Committee (HRBSC) in 1993, with about 18000 MT Halon 1301.

China

China at present is one of the largest Halon manufacturing country producing over 10,000 MT Halon 1211 in 18 plants and 1000 MT Halon-1301 in one Plant. There are over 200 Halon equipment and system manufacturing companies both in private and public sector in China. Chinese Sector Plan for Halon Phase out has recently been prepared according to which half the Halon production plants will be closed by 1998, and rest by 2003 (Halon 1211) and 2005 (Halon 1301) in various stages.

Present Halon alternative strategies of China is to adopt

(a) ABC Powder, CO2 and AFFF for Fire Extinguishers

(b) CO2, FM 200, NAF SI II, FE-13, Inert gas & possible water mist for new systems, until more suitable alternatives are available.

Russia has reduced its Halon 1211 and 1301 production and continues to produce about 250 MT/annum of Halon 2402 to meet their domestic needs.

Russia plans a Halon Bank with members from Ministries of

- Defence
- Atomic Energy
- Civil Aviation
- Sea Transport and

- Representatives of Gas Industry

Similarly other European Countries have stopped production and adopted alternatives except for certain critical uses for which they have Departmental, National or regional Banks in Operation such as

Canada	-	Under writers laboratory Canada holds about 2000 MT
France	-	6000 MT
Denmark	-	120 MT
Sweden	-	2000 MT
Poland	-	200 MT etc.

Commercial Halon recycling and reclamation centers

In order to serve the shipping and aviation industry, commercial recycling centres for CFCs and Halons have been set up by private companies. Such centres are in operation in Singapore, Europe, USA, Australia, Japan, UK etc. Most of these recycling centres are in position to supply recycled Halons to other Member Countries to meet their critical needs.

Note : Three projects have been approved in India for recycling/ reclamation of H-1301 along with their Halon-1211 Conversion projects.

APPENDIX - B

Important Properties of Chemical Halon Alternatives

Designation	Formula	Min Design concention (%V/V)	LOAEL (% V/V)	ODP	GWP (100Yr) CO_2(=1) (8)	Atmospheric Life Time
Halon 1301	CF3Br	5	7.5	10	5600	65
HFC 227ea (FM-200)	C3F7H	7	10.5	0	2900	36.5
HFC-23	CHF3	16,18	50	0	11,700	264
HFC-236fa	C3H2F6	6.4	15	0	6300	209
HCFC-124	C2HC1F4	8.5	2.5	0.022	480	6
HFC-125	C2HF5	10.9	10	0	2800	32.6
HCFC Blend A (NAF SIII)	HCFC-22 82% HCFC-123 4.75% HCFC-124 9.5 Organic 3.75%	11.9	> 12	0.036	1450	12
FIC-1311	CF31	3.6	0.4	0.0001	<5	<1 day

APPENDIX - C

Important Properties of Inert Gas Halon Alternatives

Trade Name	Designation	Formula	Storage Pressure (psi(bar)@20^{o}C	Minimum Design Conc(%V/V)	LOAEL (% V/V)
Halon 1301	Halon 1301	CF3Br	360(25)	5.0	7.5
Inergen	IG-541	N2-52% Ar-40% CO2-8%	2180(15) OR 2900 (200)	40.3	52
Argonite	IG-55	N2-50% Ar-50%	2220(153) 2980(204) 4480(306)	37.5	52
Argotec	IG-01	Ar-100%	2370(163)	33.6	52
Nitrogen	Nitrogen	N2-100%	2180(150)	38	52

APPENDIX - D

Expected Declining Trend of Halon - 1211 Consumption in India (MT)

Year	Unconstrained Demand	Constrained Consumption
1991	600	550
1992	700	266
1993	800	287
1994	900	237
1995	975	206
1996	1050	168
1997	1125	162
1998	1200	75
1999	1275	75
2000	1350	50
2001	1400	25
2002	1450	15
2003	1500	15
2004	1600	10
2005	1700	5

The consumption demand met either by production, import, recycling, recovering etc.

APPENDIX - E

Expected Declining Trend of Halon -1301 consumption in India (MT) with (Multilateral Fund Support)

Year	Unconstrained Demand	Constrained Consumption
1991	220	200
1992	240	120
1993	260	110
1994	280	110
1995	310	90
1996	340	66
1997	380	59
1998	420	50
1999	460	25
2000	500	10
2001	540	5
2002	590	5
2003	640	5
2004	700	5
2005	760	5

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INDIAN HALON PHASEOUT STRATEGY

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