STEPS TOWARD HALON PHASE-OUT, PROPOSED SUBSTITUTES AND ALTERNATIVE FOR FIXED FIRE SUPPRESSION SYSTEMS

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ABSTRACT

Following the ratification of Vienna Convention for Ozone Layer Protection and the Montreal Protocol, Indonesia will implement the phasing-outof halon at the end of 1996. Questions are increasing especially from the users where halon has been used for many years as the most effective fire extinguihsing agent, concerning halon substitutes, alternative systems as well as the handling and utilization of the existing halon. Halon can still be used for *critical and essential uses*, however, such usage has been gradually eliminated due to the emergence of halon-like replacements. A concept of halon banking system is proposed to be considered, taking into account several aspects such as enforced regulation, institutional involvement, technology as well as financing. This paper gives a general overview regarding phase- out implementation, alternative fire extinguishing systems and concept on halon banking system with special reference to Indonesian case.

Keywords : halon phase-out, ozone depleting substance, global warming potential, inert gas, water mist system, halon-bank.

INTRODUCTION

Overwhelming scientific evidence shows that the increased used of *chlorofluorocarbon* (CFCs) and halons collectively known as ozone depleting substances or ODP, have seriously damaged the earth's ozone layer. There is already one growing *ozone-hole* in the Antartic region and others forming in the Northern and Southern hemispheres. These holes are exposing world populations to the harmful effects of increased ultra-violet radiation leading inter-alia to skin cancer.

The evidence that CFCs and halons are the main cause for the depletion of the ozone layer has stirred up the worldwide concern. The need for global action to protect the ozone layer has resulted, in 1987, in the Montreal Protocol on the control, substitution and elimination or substances that deplete the ozone layer. The Protocol requires that all countries freeze their consumption and production of ODS to the year of 1986 levels, and this reduction should progressively take place to the year 2000. Special provision is made for developing countries (article-5 countries) with low consumption level of ODS, by allowing an additional 10 year grace period up to the year 2010 to comply fully with the final provision of the Protocol.

ODS CONSUMPTION IN INDONESIA

Indonesia is not producing nor exporting ODS. All ODS available and used in Indonesia are imported. The total ODS consumed in 1992 is 7,815 metric tonnes, which is equivalent to Ozone Depleting Potential (ODP) of 6,567 tonnes. From this figures, CFC-12 was the substance (53.28%) most used, followed by Trichloroethane (TCA) of 28.13%, CFC-11 (11.94%), halons (2.63%), CFC-113 and 115 (2.65%) and Carbon Tetra Chloride (CTC) of 1.47%.

In term of ODP, the CFC-12 has the most used substance (63.4% of the total), followed by halons (14.8%), CFC-11 (14.2%), CTC (3.35%), CFC-113 & 115 (2.3%), and TCA (1.93%). Furthermore, based on ODS used in industry, the distribution of ODP in 1992 is as follows : air-conditioning and refrigeration industries are the most substance used, followed by *aerosols* (30.5%), foam (15.6%), *halons* (14.8%) and solvent (7.2%), while methyl bromide, HCFC and HBFC are not included in the country programme.

It is clear that although halon consumption in metric tonnes is relatively low, but due to its high ODP value, halon comes as the *third* biggest consumption after CFC-11 and 12. The depleting potential of halons can be 10 times higher than the CFCs. The urgency to phase-out halon is because of its destructive potential to the ozone layer. Production of halons in USA, Japan and Europe has stopped by 1 January 1994, which makes it very difficult and costly to buy new halons.

Based on ODS consumption in 1992, with no restriction of using ODS, it is predicted that the total consumption of ODS will be equivalent to approximately 500,000 ODP tonnes. Therefore, Indonesia decided to accelerate phasing-out ODS by end of 1997, where halons will be done a year ahead (1996).

IMPLEMENTATION OF HALON PHASE-OUT

Indonesia has ratified the Protocol through Presidential Decision (KEPPRES)no 23/1992 and move faster by establishing a National Committee for Ozone Layer protection and ODS Phase-out under the supervision and coordination of the ministry of Environment (KLH). In the past year, the Committee worked unflaggingly to prepare a comprehensive Country Programme, which was approved by the Executive Committee for the Montreal Protocol in March, 1994. The program proposes the phase-out of CFCs and other ODS by end of 1997, while halons will be phased-out by end of 1996.

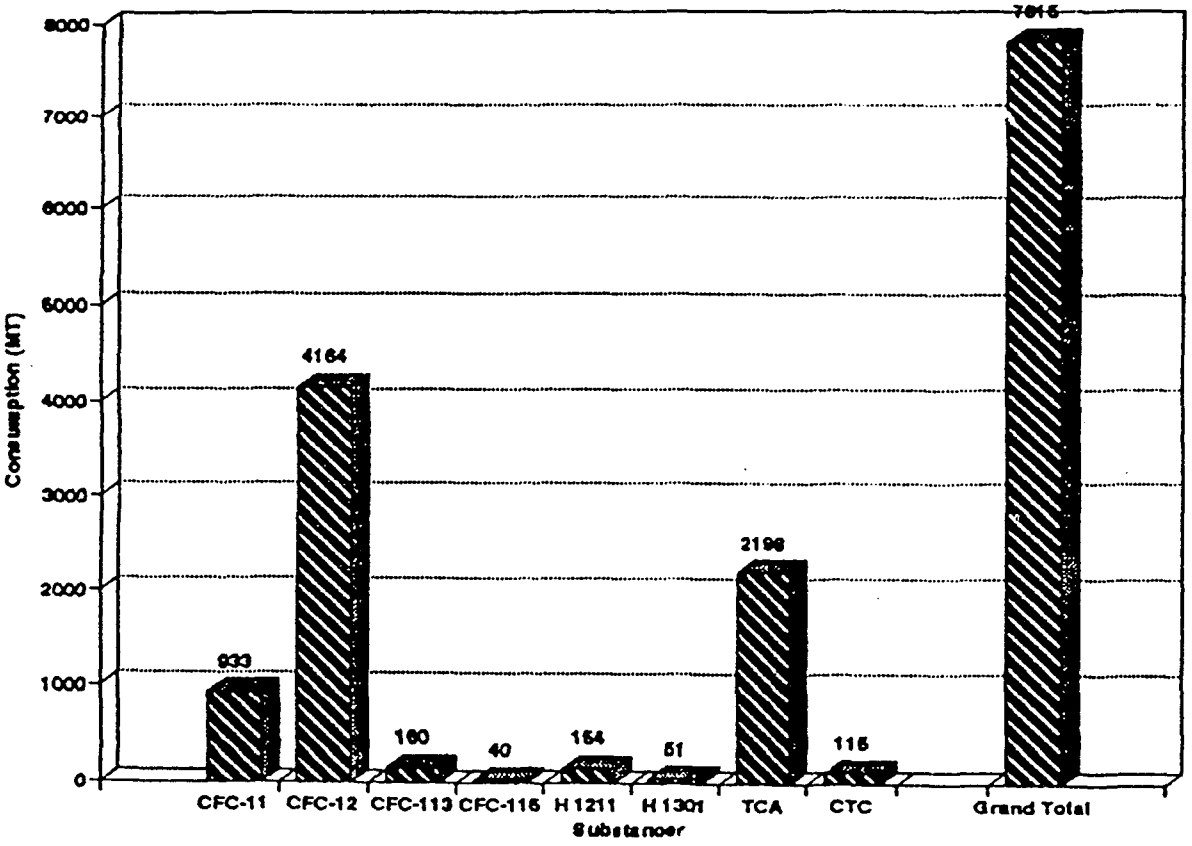

Figure 1 ODS consumption in Indonesia in 1992

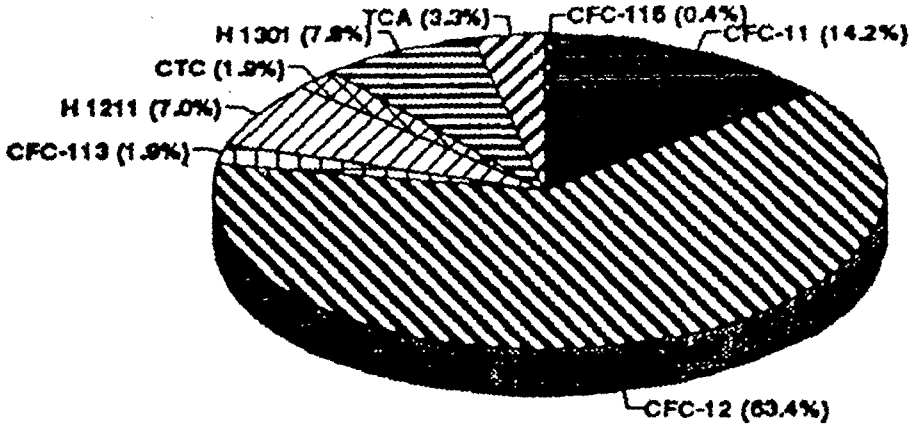

Figure 2 ODS consumption shares by substances (1992)

The implementing steps of halon phase-out will be as follows :

January 1994 - December 1994	:	Disseminating information and promoting public awareness
January 1994 - December 1995	:	Setting-up & operating a National Halon Banking System
December 1994	:	1. Stop import and production of aerosol type extinguisher using halons or other ODS
		2. Stop the import of new (virgin) halon 1301
December 1995	:	Stop the installation of new fixed type halon fire extinguishing system except for essential uses.
December 1996	:	Stop import and production of new portable halon fire extinguishers.

Due to country steps for ODS phase-out as stated in Country Programme, all parties concerned in conducting activities related to the uses of ODS should be aware and prepare for the success of the program. The main *principle* is to guarantee that the financial loss suffered by the industry and society should be kept to a minimum as possible.

In support of the implementation of ODS phase-out, several policies and regulations concerning ODS phase-out, have been recommended by the Government, are as follows :

(1) Policy concerning capital investmment to support alternative technologies which are environmentally safe and friendly,
(2) Policy to provide certain *labels* to be placed on goods or commodities based on their characteristics toward the living environment (eco-labelling),
(3) To control and supervise the implementation of ODS phase-out.
(4) To take some measures in avoiding the negative implications of ODS phase-out on the development of national industry,
(5) To prohibit the establishment of any new industry using ODS as well as the capacity expansion of ODS-use industries,
(6) To carry-out regulatory measures including import regulation of ODS,
(7) To encourage foreign investors in Indonesia to use non-ODS technology in their processing & manufacturing activities,
(8) To carry-out technology transfer activities e.g through training, workshop & seminar, courses and similar activities,
(9) To provide insentives to industry that change to non-ODS usage, while imposing dis-insentives to those who still use the ODS,

(10) To promote scientific *research and development* of non-ODS systems and technology, while constantly participating in every international program as well as on the development of Montreal Protocol functions and activities,

(11) To promote public awareness and disseminating information regarding the ozone layer protection, ODS phase-out and evaluating the economic and social impact resulting from ODS phase-out activities.

HALON SUBSTITUTES & ALTERNATIVES FOR FIXED SYSTEM

One of the major challenge to the fire society is to find suitable replacements for existing fixed installed halon fire extinguishing systems and to ensure the same degree of safety. The main areas for use of halon fixed installation are among others computer rooms, telecommunication, control room, offshore installations, machine room at ships, and storage of flammable liquids and hazardous chemicals.

There are at least two approaches in this particular aspects. First is using compatible halon-like chemical replacements which have been widely known and accepted. Second is using the existing technology and newly developed fire extinguishing system based on traditional and environmental friendly extinguishing agents such as water, foam, powder, CO_2, inert gases etc. In the following some of the replacement agents and available alternatives are reviewed.

Halonlike Replacements

As a result of the phase-out of halon production, considerable effort has been made by the chemical industry over the last years to develop a new range of effective fire extinguishing agents which are environmental friendly. The new agent should be an effective fire extinguishing agent, clean, have a non zero ODP or GWP (global warming potential) and not be toxic at required concentration.

Report of Halon Technical Committee issued on July, 1993 recommends several halon chemical substitutes i.e :

FC-3-1-10 (C_4F_{10}), with the trade mark is PFC-410
HFC-227ea (C_3F_7H), with the trade mark is FM-200
HFC-23 (CHF_3), with the trade mark is FE-13
HFC-125 (C_2HF_5), with the trade mark is FE-25
HCFC Blend A (HCFC-123,22,124 etc), the trade mark is NAFS-III
HBFC-22B1 (CHF_2Br), with the trade mark is FM-100

NFPA-20001, 1994 edition classify the the following agents as *clean agents* (Table-1).

TABLE-1
Clean Agents (NFPA-2001)

FC-3-1-10	Perfluorobuthane	C_4F_{10}
HBFC-22B1	Bromodifluoromethane	CHF_2BR
HCFC Blend A	Dichlorotrifluoroethane HCFC-123 (4.75%)	$CHCl_2CF_3$
	Chlorodifluoromethane HCFC-22 (82%)	$CHClF_2$
	Chlorotetrafluoroethane HCFC-124 (9.5%)	$CHClFCF_3$
	Isopropenyl-1-methylcyclohexene (3.75%)	
HCFC-124	Chlorotetrafluoroethane	$CHClFCF_3$
HFC-125	Pentafluoroethane	CHF_2CF_3
HFC-227ea	Heptafluoropropane	CF_3CHFCF_3
HFC-23	Trifluoromethane	CHF_3
IG-541	Nitrogen (52%)	N_2
	Argon (40%)	Ar
	Carbon dioxide (8%)	CO_2

North American Fire Guardian is marketing a blend of HCFCs with the same physical properties as Halon 1301. however, the ODP is 0,04, so this chemical has to be phased-out eventually, as well as production level will freeze in 1996.

HFCs have an ODP of zero but a lifetime of several hundred years in the atmosphere. This make the Global Warming Potential is high. Fully fluorinated organic compounds are manufactured by 3M company and marketed under the name of PFC (perfluorocarbons). The ODP is zero but the GWP is as high as HFCs.

Water Based Supression Systems

Water is the most widely used fire extinguishing media and more than 95% of all fires are controlled and extinguished by water. For fixed fire extinguishing installations, automatic water sprinkler is the traditional solution and has been widely used during more than 100 years.

The requirements to a fire extinguishing system has however changed. Aspects as value and sensitivity of objects, environmental requirements etc, has made it necessary to develop the traditional sprinkler system.

Automatic water sprinkler systems are connected to a main water supply, either the public water supply and/or a water tank/reservoir. Piping is installed to connect heat sensitive sprinkler head located throughout the protected area. In case of heat developing from a fire, the sprinkler heads above the fire is activated and release a designed amount of water over a designed area. The sprinkler system is so designed, that a number of sprinkler heads can operate simultaneously and still deliver the designed amount of water per m^2 floor area without a reduction in the water coverage. It is important to emphasize, that only sprinkler heads exposed to heat will open.

(1) *Pre-action sprinkler system*

For some water sensitive areas, additional protection can be established by using a "pre-action sprinkler system". A pre action system have dry pipes and a detection system to open a valve so that the dry pipes can be filled with water. Sprinkler heads still have to be activated by heat from a fire.

(2) *Fine water mist system*

Fine water mist system is presently under development. Water is applied as very fine droplets 80 - 200 µm. Both low and high pressure system exist. By using fine droplets, the amount of water for extinguishing fire is much less than an ordinary sprinkler system.

(3) *Aquaspray*

The low pressure system are operating with 5 bar and consist of a water container and a nitrogen container, two pipes (12 mm and 15 mm) connect the containers with a special designed nozzles, where the two media are mixed and the fine water droplets formed.

(4) *Hi Fog*

The high pressure system consist of pump, water supply and special designed open heads equal to a deluge system.

Inert Gas System

The system consists of two major gases, namely nitrogen and argon, with the purpose to provide a mixture of gases capable of starving a fire of oxygen, from normal volume concentration of 20.9% to become 12 - 14% of volume, which makes fire gradually extinguished. A design level for oxygen concentration of 12% is recommended. This ensure sufficient low concentration to stop the combustion and high enough to ensure safety of the occupants for time necessary to reach safety.

The system consists of containers, piping and nozzles. The system might be activated automatically by a detection system or manually. As the experience with such systems and the effect of low oxygen concentration is insufficient, the room should be activated before the nitrogen is released.

There are 3 (three) inert gas system, as follows :

1. *Inergen* : 52% Nitorgen, 40% Argon, 8% CO_2 (Ansul/Wormald)
2. Argonite : 50% Nitrogen, 50% Argon (Ginge Kerr)

In Inergen, a small amount of CO_2 is added to increase the breathing of people who might be present in the room. The minimum oxygen concentration necessary to support is called the oxygen index of the material. The oxygen index depends on the chemical composition, the physical dimensions, the sort of fire, and to some extent, the composition of other gases which replaces the ordinary atmosphere.

For a majority of combustible solid materials an oxygen concentration of more than 15% is required to support a flaming combustion in the material. If the fire has developed into a deep seated fire (e.g glowing wood or paper), combustion can take place at a lower concentrations. For practical use of inert gases in fire extinguishing or explosion prevention much lower oxygen concentration must be achieved. The values mentioned are obtained from laboratory tests. For safety precaution more inerting agent should be used, when inerting a compartment, not only the air but also some of the inerting media are displaced.

The difference with halon is that the inert gas system require high pressure and having bigger volume, just as high pressure CO_2 system. Toxicity is often the most important parameter when selecting the inerting agent.

CO_2 System

Carbon dioxide extinguishes fire by displacing and diluting normal air. As a result fires are extinguished by straving them of oxygen. The main advantage of CO_2 is that it will liquify at room temperature when pressured to approximately 50 bar. In this way large volumes of CO_2 gas can be released from a moderate volume of storage cylinders. When the temperature of the storage cylinders passes above the critical point, the pressure will rise dramatically. For this reason CO_2 cylinders for tropical climate must be filled with a reduce volume.

For storage of big CO_2 volumes e.g on board ship a low pressure tank with refrigerator unit might be economical. When releasing CO_2 from a liquified storage solid CO_2 snow is formed at a sublimation temperature of -78°C. This CO_2 snow is electrostatically charged and might cause ignition of flammable gases by electrostatic discharge (ESD). Although the temperature is low, the cooling effect of CO_2 snow is moderate due to a low heat of sublimation. Several tests in Danish on computer installation in operation have shown that live circuits can be exposed to snow forming CO_2 releases without damage.

The system consist of containers, piping, nozzles, a detection system or a manual release system to trigger the valve. For safety reasons, the room has to be evacuated before the CO_2 is released. A delay from the activation, and warning to occupants, of 30 to 60 seconds is required.

Foam System

Fixed foam system mix water with foam concentrate and then aerate the mixture. The resulting foam is light enough to blanket and smother flammable liquid pool fire. Foams also cool hot surfaces. Various types of foam is available on the market. High expansion foam has been examined for protection of some special room, where the main idea is to prevent oxygen to reach the fire.

Passive Fire Protection

With the phase-out of halon as an effective media, there is an increase attention to the application of passive fire protection concept. Several concepts such as ignition prevention, control of fire spread, establishing firesafety zones within a building, compartmentation and consideration on save separating distance have been increasingly implemented with the purpose to reduce the hazard caused by a fire when active fire protection system may fail or delay.

Some methods used in the system include :
- to limit the use of combustible and flammable materials,
- to reduce fire load,
- to establish fire-safe areas through compartmentation,
- to provide safe means of escape e.g pressurized stairwells, evacuation facilities etc,

- smoke venting system,
- site planning for fire safety

Firesafety Management

To ensure safety in a building particularly in specific rooms such as control rooms, computer and data processing rooms, telecommunication rooms, measures such as preventive maintenance, establishing of no-smoking areas, providing back-up files, safety design and manned facilities can be considered as an alternative solution. Other activities on firesafety management such as firesafety auditing, fire drill & training, pre-fire planning are becoming important aspects to be implemented to increase safety against fires.

HALON BANKING SYSTEM

Scope

The halon banking system is established to enable the following purpose can be carried out :

a. to identify and record the existing stocks of halon,
b. to keep a register of users and their requirement,
c. to facilitate the transfer of available halon from one user to satisfy the need of another,
d. to monitor the transfer of halon between users,
e. to act as a conduit for sales of halon,
f. to do recovery and recycle of halon,
g. to discourage emission of halon to atmosphere,
h. to set-up price mechanism for initial receipt of product, where initially small business and community users of the scheme will be subsidised to encourage their participation,
i. to implement an acceptable pricing structure for sale of product under the essential use criteria,
j. to maintain current information on international requirement for halon as well as internal development concerning halon phase-out and its implementation.

Those scope of activities are carried-out either by the system and its subsystem depending on the pattern of organization or organizational set-up.

Organization set-up

The organization set-up and management form of halon banks is not always identical in each country. There is obviously no universal template for *halon banks*. This is primarily because the key element of the banking process is the reversal of the original supply/distribution process which vary from country to country. However, it is possible to derive the key elements needed in each individual country.

In some countries the fire equipment suppliers play a major role (Denmark, Switzerland, UK), in the USA they have minor part. This is because of the historic shape of the halon supply market. Again in Switzerland, for example, the users play an almost passive role whereas they are the prime movers in most of the other schemes.

Government too have a widely differing function in this scheme. In some cases, such as Malaysia, the government imposes a regulatory frame-work because they wish to control the management of the halon stocks within the country. On the other hand (UK, USA) governments have left it to the participants to define the operating frame-work and permit market forces to prevail. However, it is Government who are uniquely placed to act as facilitators of the process, to provide as minimum a *forum* for discussion so that a strategy can be prepared. it is also important that initiative taken by Governments do not hinder the collection, transport and wise management of recovered and recycled halon.

Recycling and standards of material

Halon for transfer may need to be recycled, so that any strategy must provide access to such facilities. At the most basic this would be a list of companies who have or have access to recycling facilities. Those users who need halon have to be assured that it is fit for use in fire protection application and therefore has to be some level of confidence in the material. This can be provided either by requiring material to be recycled or to a certain agreed standards (ISO 7201, ASTM ES 24-93) or by knowing its provenance - a history of where it has been used, stored etc.

PROPOSED HALON BANKING SYSTEM

Organization structure

Since the main purpose of halon bank establishment is to carry- out handling and utilization of the existing halon, to avoid emission to the atmosphere, as well as to monitor national halon , inventory; and considering the spread of halon users involving petrochemical industries, telecommunication, aviation, security & defence, and high-rise buildings, it is considered necessary to manage the system under the supervision and control of the government i.e Ministry of Environment (KLH) assisted by the technical team representing several related ministries and institutions, such as industry, commerce, finance, public works, health, transportation, testing laboratories, research institutions, universities, as well as manufacturers, suppliers and professional association.

A secretariate of halon bank (SHB) is set up to house day by day activities. It can also be given more significant role as a communication forum or clearing house, where the physical activities are done by several established halon banks. In this case SHB has function to monitor existing halon through setting- up tracking system, provide lists of halon users, recycling stations, destruction agents, testing laboratories, etc.

There are at least 3 divisions within the halon banks e.g recycling & recovery, storage and administrative and marketing division. In addition to that, halon bank may be set up in PERTAMINA, Security & Defence (HANKAM) and Manufacturer/Industry.

Financing

Each halon bank may arrange reasonable price setting between halon bank and halon users. There is still an option whether such price setting is controlled by the secretariate of halon bank (SHB) or SHB will determine the net price. SHB is operated under the initial financial support of government and from the services given to halon banks, such as providing data and information, proposed regulations, dissemination & courses, as well as contribution fees levied from the halon banks.

A suitable system of financing is subject to be further discussed and negotiated between Ministry of Environment and technical halon team.

Organigram

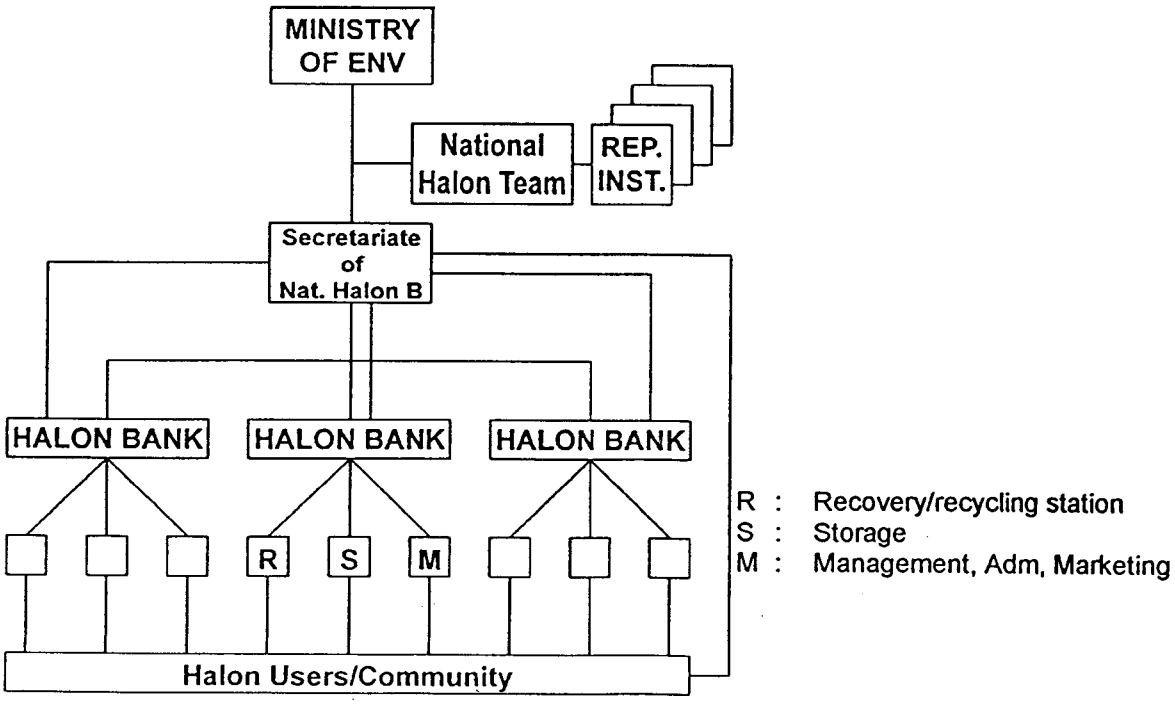

Figure 3 Halon Banking System

CONCLUDING REMARKS

1. With the phase-out of halon, there appears some problems inter-alia the replacement of halons and alternative systems, what to do with the existing halon, operational mechanism of halon bank and matters related to dissemination and publicawareness. Significant questionsare the replacement or substitution of halon as well as alternative systems.

2. There are at least four criteria to be fulfilled by halon substitute, e.g *effective, clean, zero ODP, no effect on GWP and non toxic.* The effort for obtaining the compatible replacement system, especially th one that is effective, clean and environmental friendly, has been carried out and developed.

3. There are several chemical replacements of halon e.g HFC-227ea (FM-200), HBFC-22B1 (FM-100), HFC-23 (FE-13), HFC-125 (FE-25), andHFC Blend A or NAFS-III . Other systems such as inertgas system (Inergen etc) has been used. Other alternative systems such as water mist-technology, CO_2 system, and foam system have been developed to the stage that may be proposed to fill the gap.

4. In line with the implementation of halon phase-out, there is a necessity to handling and utilization the existing halon stocks as well as fulfilling the essential uses through the establishment of halon banking system.

5. Since there is no universal pattern for halon banking system and management, a concept of halon banking system is proposed taking into account the specific condition related to regulation, institutional involvement, technology as well as financing aspects.

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