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DOSSIER

on

(HIGH-EFFICIENCY PARTICULATE AIR)

HEPA Filters

for use in nuclear facility ventilation systems

- **In the event of an accident, these filters are all that stands between the radioactive materials inside and the surroundings outside of these facilities.**
- **For filters to be certified as nuclear-grade, the performance standards must be written into the code, and that cannot be done unless there are test facilities to qualify the filters.**
- **Evidence has mounted about the failures of HEPA filters to protect workers, public health and the environment .**
- **Court documents by an expert who is a former Livermore Lab scientist in the US – Marion Fulk - whose career experience is with nuclear filtration issues, in particular HEPA filters, has made 3 expert declarations in the context of a current litigation under the U.S. National Environmental Policy Act for force the U.S. government to further analyse risks caused by HEPA filters.**
- **In addition to testifying on his own first-hand knowledge, many of the references Fulk cites are to documents that were presented at past Department of Energy-sponsored HEPA air cleaning conferences.**
- **A completely fail-proof HEPA filter has yet to be designed.**
- **HEPA filters are our only hope against environmental contamination and deadly health risks from radioactive emissions at plants such as the**

PBMR FUEL PLANT AT PELINDABA

It is no longer good enough to claim something is safe when mounting evidence the world over has now found it is not. Therefore our NEMA laws make provision for a “no-go option” and open discussion on “alternatives”. Let’s make good use of it in South Africa for the sake of our environment, good clean crops, safe water, clean air and for our children and all the children still to come.

PREVIEW

1. **Three expert declarations in the context of a current lawsuit under the U.S. National Environmental Policy Act for force the U.S. government to further analyse risks caused by HEPA filters were made, under oath, by Marian M. Fulk in the U.S. District Court.**
2. **These declarations are submitted separately with this dossier. They were filed on, respectively, 18 February 2004, 20 April 2004, and 30 June 2004.**
3. **The litigation was an attempt to compel the U.S. government (specifically the Dept. of Energy) to conduct a more thorough environmental review before operating a bio-warfare agent research facility at its Livermore nuclear weapons laboratory (Livermore Lab, or LLNL).**
4. **The suit was partially successful in that the government was ordered to prepare an environmental review of the potential consequences of a terrorist attack on the proposed facility. This the government did – but extremely poorly. So the case is back in court at present over that issue.**
5. **The case, and the declarations on HEPA filters have bearing in terms of all nuclear ventilation applications.**
6. **Extracts from Court records of Marion M. Fulk's declarations, including his credentials, are listed below.**
7. **Further documentation on HEPA filters herewith presented includes:**

    - **Penetration of a HEPA filter as a function of particle size - from the 18th DOE Nuclear Airborne Waste Management and Air Cleaning Conference, Baltimore 1984.**
    - **1999 CPEO Military List Archive - email from Marylia Kelley on Plutonium Filter Problems at Livermore Lab, 12 March 1999.**
    - **HEPA Filters - Information Document from Filt-air.com**
    - **Letter from Leuren Moret (former Lawrence Berkeley Lab & Lawrence Livermore Lab scientist, now an independent scientist working with "The Radiation and Public Health Project") to Congressman McDermott, dated 21 February 2003**
    - **HEPA Related Lessons Learned - list from U.S. Department of Energy website**
    - **Preview of "People of the bomb" by Hugh Gusterson with links to his writings on the failure of HEPA filters**
    - **Other web links to information on the failure of HEPA filters**
    - **The Abstract on "A Survey of Mixed-Waste HEPA filters in the DOE Complex", 2002 (submitted separately in PDF)**
    - **Email from Pelindaba Working Group to the National Nuclear Regulator requesting information on HEPA filters, March 2009**
    - **Email to the Nuclear Energy Corporation of South Africa requesting information on HEPA filters, March 2009**

Extracts from Court records of

The Declaration of Marion M. Fulk in support of the plaintiffs motion for summary judgement

In the United States District Court Case No: C-03-3026 SBA
Between
Tri-Valley CARES & others vs US Dept of Energy, National Nuclear Security Administration & others

"I am a Chemical Physicist, retired from the University of California, Lawrence Livermore National Laboratory in 1984, where I served 18 years as a staff scientist in chemical physics and material sciences. At LLNL most of my work was classified, but it included the study of radioactive rainout and aerosols; their dynamics, initiation and growth. At LLNL, I studied problems associated with aerosolized particles and their capture by High Efficiency Particulate Air filters, commonly called HEPA filters. I also studied various toxic and radioactive materials including uranium and plutonium.

"I have worked professionally on these issues for the University of California and the Department of Energy (DOE) and its predecessor agencies, including the Atomic Energy Commission, since my work at the University of Chicago where I conducted research on biological systems beginning in 1945.

"I have personal knowledge of the following…and four decades of experience with aerosols, HEPA filter vulnerabilities, problems and contaminant release scenarios.

"HEPA filters are the primary method used at LLNL to filter hazardous and radioactive emissions. So, too, will HEPA filters be the last bastion of defence before biological agents escape into the environment from the proposed BSL-3 facility at LLNL.

"Most HEPA filters at LLNL are flimsy, weak, fibreglass paper and glue structures mounted in wood or metal frames….HEPA filters can fail completely when wet, plugged, hot and over-pressured from fires, explosions, blowers and even severe storms. With age, minor forms of these threats can cause filter blowouts. E.H. Carbaugh, in a survey of DOE facilities, found that filter failures can cause filter failures occur in approximately 12% of all installed paper-glue HEPA filters. Handling or installation damage accounted for about 20% of the reported failures. A fragile HEPA filter system is all that stands between nearby residents and workers and routine processes and accidents in the LLNL BSL-3 that will produce potentially deadly biological aerosols.

"When HEPA filters are operating normally, under the best of circumstances, they have a translucency for particles of approximately 0.1 micrometer in size. (Approximately 1 out of 1000 gets through the filter.) …HEPA filters have a reduced efficiency (effectiveness) capturing particles between approximately 0.05 and 0.3 micrometers in size, with the largest inefficiency in the 0.1 micrometer range.

"…HEPA filters may become structurally damaged under a variety of conditions and expose the public and the environment to large quantities of pathogens… with each one litre container of a single biological agent containing as many as one hundred billion (100,000,000,000) cells or organisms.

"…In May 1999, the Defence Nuclear Facilities Safety Board concluded that HEPA filter systems at Department of Energy facilities like LLNL may be vulnerable to failure when most needed.

"…HEPA filters can fail catastrophically in numerous accident scenarios, including events initiated by earthquake, explosion or fire….Each of these, as well as other potentially catastrophic accidents that may occur … poses a serious threat to public health and the environment. Yet, the EA does not deal with any accident or off-normal HEPA filter events.

"…Each type of HEPA filter raises specific issues or problems. Since the EA doesn't discuss them, no mitigation measures are proposed. The EA…rely on unduly optimistic assertions about HEPA filters derived from an internal report done by an employee of indeterminate stature at the Dept of Energy's Los Alamos National Laboratory....that internal lab report has not been made publicly available and is missing from the Administrative Record …there is a wealth of peer-reviewed, credible and publicly-available expert data on the efficiencies of and problems associated with HEPA filters. Therefore, the omission of this information and any detailed analysis of HEPA filter deficiencies…is both baffling and inexcusable.

If a thorough Environmental Impact Statement is undertaken before operations commence…there will then be a proper opportunity for a detailed analysis of HEPA filter and other accidental and "routine" release scenarios to be conducted. – *From the Declaration of 10 Feb 2004, under oath.*

"In my professional judgement, using two HEPA filters in series…in inadequate to protect on-site workers and the community. As I testified earlier, HEPA filters are least effective against bioagents, particularly particles approximately 0.1 micrometers in size.

"...many of the potentially lethal pathogens that may be used in … are of the particle size most likely to escape capture by HEPA filters, even when the filters are operating properly…not merely during accident conditions.

"…There are many accident conditions that can reduce HEPA filter efficiency to well below 95%. In fact, HEPA filter effectiveness can be – and has been – reduced to zero in some accident conditions, such as fire.

"…Known problems with HEPA filters are not fully discussed and no mitigation measures are outlined.

"…Under perfect operating conditions, on average, 1 our of every 1000 of the biological agents used in ….in the 0.1 micrometer range will penetrate a single HEPA filter. With two HEPAs in series, the average number of 0.1 micrometer size bio-agents that will escape is at least 1 our of every million (1,000,000), a number that represents a still unacceptable risk when a facility is handling large numbers of potentially lethal microorganisms. Moreover, this estimate is very conservative and may understate the number of organisms released to the environment because I have given the second HEPA filter the same mathematical efficiency as the first, when, in reality, it will be *less* efficient because particles that passed through one HEPA filter are more likely to pass through a second filter than those that didn't."

"…the facility will handle up to a liter at a time of each pathogen at a concentration of 10 to the power of 8 per millilitre. At this concentration, one liter equals about one hundred billion (100,000,000,000) cells or organisms. Therefore, if a litre containing a pathogen in the 0.1 micrometer size range were to become airborne, one hundred thousand (100,000) cells or organism could escape two HEPA filters in series and be released into the environment. Note, this is the number that would be released to the environment if both HEPA filters were operating perfectly….This information was not in the EA.

"…Thus, a much more comprehensive analysis is called for. Failure to do so is scientific negligence and puts workers and the community at risk." – *Declaration of 29 July 2004, under oath*

Penetration of a HEPA filter as a function of particle size

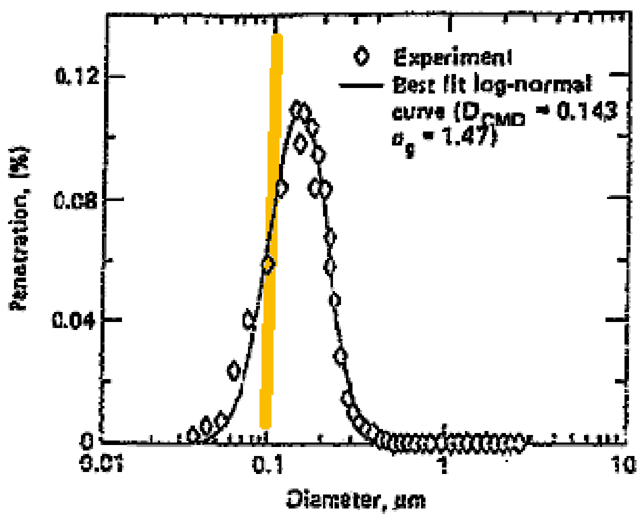
18TH DOE NUCLEAR AIRBORNE WASTE MANAGEMENT AND AIR CLEANING CONFERENCE, Baltimore 1984.

Also see:
Prototype Firing Range Air Cleaning System
GLISSMEYER et al

Experimental penetration of particles through a HEPA filter – determination that approximately 0.1% in the 0.1 micron particle range will pass through the filter. If there are 100,000 particles 0.1 micron in diameter per cubic centimeter of air, then 120 per cubic centimeter of air will pass through a HEPA filter. In one day an average man will inhale 28 million particles in the 0.1 micron range through a HEPA filter.

18th DOE NUCLEAR AIRBORNE WASTE MANAGEMENT AND AIR CLEANING CONFERENCE

Baltimore 1984



Concentration of 0.1 micron Particles in Air

100,000 per cubic centimeter of air

1 billion per cubic meter of air

Attachment 4

Fig. Experimental penetration of a HEPA filter as a function of DOS particle diameter.

http://www.mindfully.org/Nucs/Penetration-Of-HEPA-Filter1984.htm
http://www.mindfully.org/Nucs/Firing-Range-Air-Cleaning1mar85.htm

1999 CPEO Military List Archive

http://www.cpeo.org/lists/military/1999/msg00035.html

From: marylia@earthlink.net (marylia)
Date: Fri, 12 Mar 1999 12:32:15 -0800 (PST)
Reply: cpeo-military
Subject: Plutonium Filter Problems at Livermore Lab!

Hello cpeo folks. This has broad implications as **HEPA filters** are used by government and industry-wide. Read on... Peace, Marylia

Contact:

Marylia Kelley, Executive Director, (925) 443-7148

Sally Light, Program Analyst, (925) 443-7148 or

(510) 527-2057

For Release 3/11/99

Livermore Lab's Plutonium Facility -- A Ticking "Time Bomb"?

Community group calls on Energy Secretary to close plutonium facility; conduct immediate investigation of **filter problems**. Formerly secret documents form basis for group's demand.

On March 11, 1999, Tri-Valley CAREs (Communities Against a Radioactive Environment) will send a letter to Energy Secretary Bill Richardson demanding that he immediately shut down operations in the main plutonium building at the Lawrence Livermore National Laboratory (LLNL) while a thorough, open investigation of the problem-riddled facility is carried out. The main plutonium facility at LLNL, called Building 332, houses 880 pounds of plutonium, enough for nearly 100 modern nuclear bombs.

Tri-Valley CAREs, the Livermore-based environmental "watchdog" over the weapons laboratory, has recently received documents from the U.S. Department of Energy (DOE) in response to its Freedom of Information Act (FOIA) request for information concerning LLNL's High Efficiency Particulate Air **(HEPA) filters** in its plutonium facility. The documents were not provided until Tri-Valley CAREs, after waiting almost nine months for a response to its April 1998 request, filed a FOIA lawsuit against DOE, the Livermore Lab's parent agency.

These formerly secret documents, which total approximately 500 pages, can be made available to reporters upon request at Tri-Valley CAREs' office. They are the basis for the group's urgent letter to Secretary Richardson. Several documents are excerpted below.

The DOE documents reveal **a long history of serious problems with Bldg. 332's HEPA filters, which are supposed to protect Lab workers and the public by preventing the release of plutonium**

into the air. Plutonium, a radioactive material derived from neutron bombardment of uranium 238, is used in the making of nuclear weapons. Plutonium 239, the weapons grade isotope oft used at Livermore Lab, has a "half-life" of over 24,000 years.

Among the documents are many memos from LLNL's own filter experts outlining serious technical concerns about Bldg. 332's filter system and containing chilling warnings about potential and actual failures. Other documents describe accidents that spread plutonium around Bldg. 332, which includes many rooms and, in its entirety, covers most of four acres.

Excerpt from FOIA-ed memo of 6/6/90: "I hope it doesn't take a release like we had in late 1979 - early 1980 to spring the money necessary to solve the current problems." --
James S. Johnson, LLNL to Chuck Folkers, LLNL

"The records indicate that measurable plutonium releases to the outside air occurred in 1979-80 due to **HEPA filter failure**," stated Sally Light, Tri-Valley CAREs' Nuclear Program Analyst.

"According to these documents," Light continued, "at least one type of Bldg. 332's HEPA filters is not totally qualified for nuclear applications.
Further, **the documents show that these filters, which are made by hand from glass paper and glue, may fail when wet, hot, cold or under too much air pressure, as well as when too old.** Livermore Lab experts state in the documents we received that HEPA filters should remain in service for only 8 years maximum. Knowing this, the Lab has continued to use some of the filters in the plutonium facility for 20 to 30-plus years!"

Excerpt from FOIA-ed memo of 3/6/95: "Old filters should be discarded or only used in non-critical applications because aged filters are structurally weak." – Werner Bergman, LLNL to Ray Kahle. And, on 2/16/95: "LLNL has stored filters to 10 years prior to use and has functioning filters with 32 years of service." -- HEPA Filter Studies, by Werner Bergman, LLNL

Light went on to say that there is a risk of major plutonium releases if a fire -- always a possibility with plutonium -- occurs in Bldg. 332, causing the "blow out" of plutonium-laden filters when fire sprinklers turn on. "We are extremely concerned about this possibility, because a major plutonium fire and **HEPA 'blow out' has already actually happened at another DOE facility**, Rocky Flats, in Colorado," she said.

Excerpt from FOIA-ed memo of 3/6/95: "As stated in all three documents, **the most important issue is the potential for HEPA filter blow out during fire conditions**." – Werner Bergman, LLNL to Ray Kahle

According to Marylia Kelley, Executive Director of Tri-Valley CAREs, HEPA filters work similarly to a filter in a coffee pot, which doesn't prevent numerous small coffee particles from passing through.

"Even when the HEPA filter is working perfectly, it does not capture 100% of the plutonium. If the filters are allowed to get old, crusty, brittle and failure-prone, as the ones in Bldg. 332 have, then this may show one possible pathway by which plutonium

made its way into the surrounding community, including Big Trees Park," Kelley explained, referring to the recent "plutonium in the park" controversy. Community concern continues to rise as elevated levels of plutonium were discovered for a third time at Big Trees Park, just one half mile west of the Lab and next to an elementary school.

Kelley also stated that some of the DOE documents include Lab memos describing the long-standing inadequacy of funding for research into both filter problems and their remedies. A recent memo shows a Livermore Lab employee trying hard to juggle and stretch what little DOE funding there was in order to even partially address existing filter problems.

Excerpt from FOIA-ed memo of 3/21/98: "I no longer have any support for HEPA filter tasks and cannot charge my other projects... Because of the serious accusations regarding these filters and the potential consequences to Bldg. 332 and the Lab, I quickly conducted a series of tests (using about 100k dollars of my DOE monies initially intended for other filter tasks) to mitigate the most serious questions regarding the closed filters." -- Werner Bergman, LLNL to Tim Roberts, LLNL

"Historically, there's been very little guidance from DOE as to the filters for the entire nuclear weapons complex. Instead, each facility has been left largely on its own," Kelley said.

Excerpt from FOIA-ed document of 2/16/95: "DP [Dept. of Energy's Defense Programs] facilities have many old HEPA filters because there is no guidance and no disposal site" -- HEPA Filter Studies, by Werner Bergman, LLNL

"We will continue to monitor the **serious HEPA conditions** at Livermore Lab's plutonium facility, as well as the other problems there, **including the epidemic of plutonium criticality safety violations that resulted in the months-long shut down** of Bldg. 332 during 1997-98," said Sally Light. "As a priority, we are urging the community to join us in writing the Secretary of Energy, as well as Representative Ellen Tauscher, to demand that Bldg. 332 be closed while an immediate, thorough and open investigation of these **serious risks to public health and the environment** is undertaken."

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A copy of the letter to Secretary Richardson is available by fax on request.

++++ Please note that my email address has changed to <marylia@earthlink.net> on 3/1/99 ++++

Marylia Kelley
Tri-Valley CAREs
(Communities Against a Radioactive Environment)
2582 Old First Street
Livermore, CA USA 94550

<http://www.igc.org/tvc/> - is our web site, please visit us there!
Our web site will remain at this location. Only my email address

has changed on 3/1/99.

(925) 443-7148 - is our phone

(925) 443-0177 - is our fax

Working for peace, justice and a healthy environment since 1983, Tri-Valley CAREs has been a member of the nation-wide Alliance for Nuclear Accountability in the U.S. since 1989, and is a co-founding member of the international Abolition 2000 network for the elimination of nuclear weapons.

HEPA Filters

http://www.filt-air.com/Resources/Articles/hepa/hepa_filters.aspx

HEPA is an acronym for "high efficiency particulate absorbing" or "high efficiency particulate arrestance" or, as officially defined by the Department of Energy (DOE) "high efficiency particulate air".This type of air filter can theoretically remove at least 99.97% of dust, pollen, mold, bacteria and any airborne particles with a size of 0.3 micrometres (µm) at 85 litres per minute (Lpm). In some cases, they can even remove or reduce viral contamination. The diameter specification of 0.3 responds to the most penetrating particle size (MPPS). Particles that are smaller or larger are trapped with even higher efficiency. Using the worst case particle size results in the worst case efficiency rating (ie, 99.97% or better for all particle sizes).

HEPA filters are also employed to filter out highly hazardous aerosols such as those that are radioactive, biohazardous and highly toxic (eg. carcinogins). In the event of a nuclear, biological or chemical outbreak, HEPA filters are the last line of defense between the contamination and the those who could be exposed to it.

Contents

History of HEPA Filters

The first HEPA filters were developed in the 1940's by the USA Atomic Energy Commission to fulfill a top-secret need for an efficient, effective way to filter radioactive particulate contaminants. They were needed as part of the Manhattan Project, which was the development of the atomic bomb. The first HEPA air filters were very bulky compared to the HEPA air filters that are produced today. HEPA filter technology was declassified after World War 2 and then allowed for commercial and residential use. The following is a chronological list of events in the history of HEPA filters:

- developed during WWII atomic bomb research for containment of radioactive aerosols
- called “superimpingement” or “ superinterception” filters; later referred to as “absolute” filters
- first prototype filters used esparto grass as the filter medium
- in 1950s glass fibers were introduced into the paper
- in 1960s specifications were standardized and called HEPA filters
- in 1970s asbestos was removed
- in 1960 the first laminar flow bench was invented at Sandia National Laboratory

Typical Characteristics

At a glance, HEPA filters have the following characteristics:

- Most submicron semiconductor fabrication lines use Type-D ULPA filters as an improvement over traditional HEPAs for Class-1 and Class-10 environments.
- Usual size is 3 ft. x 6 ft. x 5.875 in. frame.
- When new, maximum pressure drop is 1 in of water = 0.036 psi
- Each ft^2 of opening corresponds to about 50 ft^2 of paper area
- Designed for 90 lfm air velocity, or 45.7 cm/sec.
- Designed for entraining 500 - 1000 grams of dust per 1000 cfm
- Are sealed into the ceiling using gel-sealed T-bars
- Typical lifespan is several years if air is properly prefiltered

Industries and Applications

HEPA air filters have been traditionally used in hospital operating and isolation rooms, pharmaceutical and computer chip manufacturing, as well as in other applications requiring "Absolute" Filtration. Today HEPA air cleaners, vacuum cleaners and air filters are used in a wide variety of critical filtration applications in the nuclear, electronic, aerospace, pharmaceutical and medical fields. HEPA air cleaners, vacuum cleaners and air filters are required by law to be used in all equipment for asbestos, lead, toxic chemical and mold abatement. These HEPA filtered products must meet the strict Military Standard 282 HEPA filtration efficiency test. Today, HEPA filters are used in a broad range of industries including:

- Microelectronics (eg. semiconductor cleanrooms)
- Pharmaceutical
- Bio and gene technology
- Chemical industry
- Nuclear air ventilation
- Waste incinerators
- Hospital operating rooms
- Emergency burn centers
- Cosmetics
- Medical industry
- Food industry
- Optical industry
- Automotive industry
- Surface engineering
- Precision engineering
- Nanomaterials
- Space industry
- Military equipment
- Power and energy plants
- Controlled and ultraclean environments for critical technologies
- Movie theatre industry
- Portable residential air cleaners

HEPA and ULPA filters are best applied in situations where high collection efficiency of submicron Particulate Matter (PM) is required, where toxic and/or hazardous PM cannot be cleaned from the filter, or where the PM is difficult to clean from the filter. HEPA and ULPA filters are typically utilized for applications involving chemical, biological, and radioactive PM. HEPA and ULPA filters are installed as the final component in a PM collection system, downstream from other PM collection devices such as electrostatic precipitately or baghouses. (Heumann 1997)

HEPA and ULPA filters are specifically designed for the collection of submicron PM at high collection efficiencies. They are best utilized in applications with a low flow rate and low pollutant concentration. Filter outlet air is very clean and may be recirculated within the plant, in many cases (AWMAI 1992). They are not sensitive to minor fluctuations in gas stream conditions (Heumann. 1997). Corrosion and rusting of components are usually not problems. Operation is relatively simple. Unlike electrostatic precipitators, HEPA and ULPA filter systems do not require the use of high voltages therefore, flammable dust may be collected with proper care (AWMAI 1992). Filters are available for a range of dimensions and operating conditions. Commercial filter systems and housings are available in several types of configurations to suit a variety of installation and operation requirements. These systems have many built in features such as testing and monitoring equipment.

HEPA and ULPA filters are useful for collecting particles with resistivities either too low or too high for collection with electrostatic precipitated (AWMA. 1992). Unlike baghouses which require workers to enter the collector to replace bagel HEPA and ULPA filters systems are designed to replace filters outside the collector housing. This makes them ideal for applications involving hazardous air pollutants (HAPs) or toxic PM. The collected PM is tightly adhered to the filter media for subsequent disposal. Bag in/bag out procedures that may be required by OHSA are easily performed with the filters (Heumann. 1997).

Construction and Function

When designing HEPA filters, there are several items that must be considered: application, environment, efficiency required, physical geometry constraints, structural requirements, system volumetric flow requirements, system operational pressures, existing air handling equipment and its capabilities, as well as maintenance, ergonomics, cost, and manufacturability.

Most HEPA filters are constructed from a mat of randomly arranged special glass fibre sheet pleated in a “V” pattern like a folded paper fan with corrugated aluminium separators between the folds. This is attached to a sturdy base, forming the core of the filter.

HEPA and ULPA filters generally contain a paper media. Newer filter designs may contain nonwoven media which utilizes recently developed fine fiber technology (INDA, 2000). Generally, the filter media is fabricated of matted glass fiber such as borosilicate microtines (EPA, 1991). The small fiber diameter and high packing density of both the paper and nonwoven media allow for the efficient collection of submicrom PM (Gaddish, 1989). The waste gas stream is passed through the fibrous filter media causing PM in the gas stream to be collected on the media by sieving and other mechanisms, as mentioned below. The dust cake that forms on the filter media from the collected PM can increase collection efficiency (EPA, 1998a).

The filter media is pleated to provide a larger surface area to volume flow rate. For this reason, HEPA and ULPA filters are often referred to as extended media filters. Close pleating, however, can cause the PM to bridge the pleat bottom, reducing the surface area (EPA, 1998a). Corrugated aluminum separators are often employed to prevent the media from collapsing (Heumann, 1997). The pleat depth can vary from 2.5 centimeters (cc) (1 in.) up to 40 cm (16 in.). Pleat spacing is generally between 12 to 16 pleats per in., with certain conditions requiring fewer pleats, 4 to 8 pleats per in. (EPA, 1998a).

The most common designs are a box filter cell and a cylindrical filter cell. In a box cell the pleated media is placed in a rigid, square frame constructed of wood or metal. The air flows from the front to the back of the filter. Box packs are approximately 60 cm (24 in.) in height and width and 6 to 30 cm (3 to 12 in.) in length (EPA, 1991). The media in a cylindrical filter cell is supported by inner and outer wire frameworks. A metal cap seals the media at one end. Air flows from the outside to the inside of the filter. This allows a higher air flow rate than a box cell since more surface area is exposed (Vokes, 1999). Typical cylindrical packs are 50 centimeters (cm) (20 in.) in diameter and 35 to 60 cm (14 to 24 in,) in length (Vokes, 1999).

Both the box and cylindrical cells seal the media to the frame or cap using polyurethane, epoxy, or other commercially available adhesive. A metal grill protects the media face from damage. The filter cell is mounted to a holding frame using a gasket or fluid seal. The filter is generally mounted on the clean air plenum (EPA, 1991). The filter can be mounted directly in the duct or in a separate housing. HEPA and ULPA filter systems require pre-filtering for large diameter PM. HEPA and ULPA filter systems are generally the final component in a PM removal system (Heumann, 1997).

The HEPA and ULPA filter cells are generally utilized as a disposable-type filter. As discussed previously, when the filter cake buildup results in unacceptable air flow rates, the filters are replaced. In most designs, replacement of the filter cell takes place at the clean air plenum and outside of the housing unit. This reduces the risk of exposure to PM by the maintenance workers. This feature is especially important.HEPA filters differ in terms of

- Filtration efficiency
- Configuration (size and shape)
- Materials of construction
- Fire resistance

Key metrics affecting function are fiber density and diameter, and filter thickness. The air space between HEPA filter fibers is much greater than 0.3 μm. The common assumption that a HEPA filter acts like a sieve where particles smaller than the largest opening can pass through is incorrect. Just as for membrane filters, particles so large that they are as wide as the largest opening or distance between fibers can not pass in between them at all. But HEPA filters are designed to target much smaller pollutants and particles are mainly trapped (they stick to a fiber) by one of the following four mechanisms:

Filtration by interception

Direct interception works on particles in the mid-range size that are not quite large enough to have inertia and not small enough to diffuse within the flow stream. These mid-sized particles follow the flow stream as it bends through the fiber spaces. Particles are intercepted or captured when they touch a fiber. With interception, particles following a line of flow in the airstream come within one radius of a fiber and adhere to it. Particles that are farther than one particle diameter will not be removed by this process. This is one reason for the high fiber volume density of the 200 cfm media. The more dense, the higher the probability of particlecapture. This effect is dominant from about 0.1μm up to about 1μm.

Filtration by inertial impaction

Inertial Impaction works on large, heavy particles suspended in the flow stream. Inertial impaction occurs when large particles are unable to quickly adjust to changes in the flow stream around fibers. The particle, due to its inertia, impacts a fiber and is captured. This effect is dominant from around the 0.5 μm region up to around 5 μm. Larger particles are unable to avoid fibers by following the curving contours of the airstream and are forced to embed in one of them directly; this increases with diminishing fiber separation and higher air flow velocity.

Filtration by Brownian diffusion

Diffusion (also known as Brownian Diffusion) works on the smallest particles. Brownian diffusion is perhaps the most mysterious of the filtering effects since it tends to defy common sense. Very fine particles in the air stream will collide with gas molecules and create a random path through the media. The smaller the particle the longer the particle will zigzag around. This random motion increases the probability of the particle contacting a fiber. This effect is dominant for all particlessmaller than 0.1μm.

Filtration by sieving

Sieving, the most common mechanism in filtration. Sieving stops large particles that are just too big to fit through the open areas of the filter. This includes all particles above 5 μm in size and larger. As you go smaller in particle size, say between 1μm to 5 μm, occasionally some of these particles get through, but the efficiency for removal is still well into the 99.9999+% range. This is still due primarily to sieve effectand the beginning of inertial impaction effect.

The particle capture effects mentioned are all subject to how the filter media is made. Fiber diameter, spacing, fiber cross section, and media thickness are big drivers in how effective a filter is. The smaller the fiber, the greater the small particle capture efficiency. The smaller the fiber spacing, the greater filter efficiency. The larger the cross section, the greater the capture capability.

Each of these has tradeoffs that must be considered however, when designing a filter. Glass and polymer fibers are the most common materials used in HEPA filters. Glass fibers can be drawn down to much smaller diameters than can polymers, 0.3um is very possible. This would suggest that an all glass fiber filter would be the best. If your not concerned about space, perhaps this would be correct. However, in order to put a large amount of media into a small space, media pleating is the best solution. Unfortunately glass is very brittle and the small fibers will break if folded too severely. This is one reason why polymer fibers are added to the media matrix. They add a significant amount of structural strength that allows pleating to be effective without significantly impacting filter performance.

Diffusion predominates below the 0.1 μm diameter particle size. Impaction and interception predominate above 0.4 μm. In between, near the 0.3 μm MPPS, diffusion and interception predominate.

The initial filter air flow resistance and final filter air flow resistance are typically measured as pressure drop across the filters.

The terminology of "True HEPA" is a loosely used marketing term. Various industries and institutions have different specifications as to how they define HEPA. For example the European Standard EN1822-1 defines a HEPA filter as ranging from 85% to 99.995% efficient against a 0.3 micron challenge. The standard adopted by commercial aircraft manufactures and many other industries is MIL-STD-282 Method 102.9.1 which requires the filter to capture 99.97% of 0.3 micron particles.

HEPA filters will have a label attach to them and normally contain the following parameters:

- Percent penetration at rated flow
- Resistance at rated flow
- Direction of flow
- Filter size
- Type of separator

Most HEPA filters are designed for the specific environment in which they will be used. Filters used in operating room environments must be able to filter out biological organisms. However, they are not subject to high humidity environments, since this would prompt biological growth on the media, and are usually placed within the lower dew point section of the ventilation system. Filters used in semiconductor clean rooms must be able to handle low level exposure to selected acid vapors, typically at temperate conditions.

Conditions That Will Damage HEPA Filters

The following is a list of potential conditions that under prolonged exposure will either permanently damage or comprimise a HEPA filter:

- Moisture: 95-100% relative humidity
- Hot air: greater than 275 °F
- Fire: direct fire or high concentrations of particulate matter produced by fire
- High pressure: 8 in. of water, gauge (in. wg) internal or differential across filter media
- Corrosive mist: dilute moist or moderately dry concentrations of acids and caustics
- Any acid and some caustics will attack uncoated aluminum separators
- Hydrofluoric acid will attack the media
- Nitric acid will attack wooden boxes making highly flammable nitrocellulose
- Shock pressures

Note: The filter exterior must not be exposed directly to outdoor environments.

HEPA Filter Performance

HEPA filters provide a very high level of filtration efficiency for the smallest as well as the largest particulate contaminants. As defined by the Institute of Environmental Sciences and Technology, IEST-RP-CC001.3 and MIL-STD-282 Method 102.9.1, a HEPA filter must capture a minimum of 99.97% of contaminants at 0.3 microns in size. The 0.3 micron benchmark is used in efficiency ratings, because it approximates the most difficult particle size for a filter to capture. HEPA filters are even more efficient in removing particles that are smaller than 0.3 microns and larger than 0.3 microns. The fact that a HEPA filter's removal efficiency increases as particle size decreases below 0.3 microns is counter intuitive. However, this is a proven and accepted fact in the filtration sciences.

Experimental penetration of particles through a HEPA filter have determined that approximately 0.1% in the 0.1 micron particle range will pass through the filter. If there are 100,000 particles 0.1 micron in diameter per cubic centimeter of air, then 120 per cubic centimeter of air will pass through a HEPA filter. In one day an average man will inhale 28 million particles in the 0.1 micron range through a HEPA filter.

HEPA filter performance is dependent primarily upon the four following characteristics:

Air Flow: HEPA and ULPA filters are currently limited to low capacity air flow applications. Standard filter packs are factory-built, off the shelf units. They may handle from less than 0.10 up to 1 .0 standard cubic meters per second (sm^3/sec) ("lhundreds" to 2,000 standard cubic feet per minute (scfm) (AAF, 2000; Vokes,1999). HEPA filter systems designed for nuclear applications require higher capacities. For these applications filter banks or modules are ducted together in parallel to increase air flow capacity (EPA, 1991). Commercially available modular systems can accommodate air flow rates in the range of 5 to 12 sm^3/sec (5,000 to 40,000 scfm) (AAF, 2000; Vokes, 1999).

Air flow capacity is a function of the resistance, or pressure drop across the filter and particle loading. As the dust cake forms on the filter, the resistance increases, therefore, the air flow rate decreases. Since the filter is not cleaned the air flow rate continues to decrease as the system operates. After the pressure drop across the filter reaches a point that prevents adequate air flow, the filter must be replaced and disposed. For these reasons, HEPA and ULPA filters are used in applications that have low air flow rates or have low concentrations of PM (Heumann 1997).

Temperature: Temperatures are limited by the type of filter media and sealant used in the filter packs. Standard cartridges can accommodate gas temperatures up to about 93 °C (200 °F). With the appropriate filter media and sealant material, commercial HEPA filters can accept temperatures of up to 200 °C (400 °F). HEPA filters with ceramic or glass packing mechanical seals can accept temperatures up to 537 °C (1000 °F). (EPA 1991)

Spray coolers or dilution air can be used to lower the temperature of the pollutant stream. This prevents the temperature limits of the filter from being exceeded (EPA, 1998b). Lowering the temperature, however, increases the humidity of the pollutant stream. HEPA and ULPA filters can tolerate some humidity. Humidity higher than 95%, however, can cause the filter media to plug, resulting in failure (EPA, 1991). Therefore, the minimum temperature of the pollutant stream must remain above the dew point of any condensable in the stream. The filter and associated ductwork should be insulated and possibly heated if condensation may occur (EPA, 1998).

Pollutant Loading: Typical pollutant loading ranges from 1 to 30 grams per cubic meter (g/m^3) (0.5 to 13 grains per cubic foot (gr/ft^3)) (Novick, et at, 1992). Dust holding capacity compares the weight gain of the filter to the rise in pressure drop during a specific period of time (air flow volume). Typical inlet dust holding capacity range from 500-1000 g/1000 scfm (Gadish, 1989). As discussed above, the pressure drop across the filter is a function of pollutant loading. HEPA and ULPA filters are best used in applications that have low concentrations of PM, or prohibit cleaning of the filter (Heumann, 1997).

Other Considerations: Moisture and corrosives content are the major gas stream characteristics requiring design consideration. As discussed previously, humidity up to 95% is acceptable with the proper filter media, coatings, and filter construction. Filters are available which can accommodate corrosive gas streams with concentrations up to several percent. These filters are constructed of special materials and are generally more expensive. (EPA, 1991)

The dust-holding capacity of a filter is dependent on the shape, size, and density of the dust particles it is exposed to. In applications with high dust concentrations, the HEPA filter should be protected by replaceable prefilters upstream of the filter. For structural design purposes, 4 lb of dust load per 1000 cfm of rated capacity can be assumed.

The following chart indicates dimensions and performances for typical HEPA filters:

Size	Dimension in. (mm)	Nominal airflow		Maximum resistance		Filter weight lb
		cfm	m^3/hr	In. water gauge	Pa	
1	8 x 8 x 3 1/16 (203 x 203 x 78)	25	42	1.3	325	
2	8 x 8 x 5 7/8 (203 x 203 x 149)	50	85	1.3	325	3.6
3	12 x 12 x 5 7/8 (305 x 305 x 149)	125	212	1.3	325	
4	24 x 24 x 5 7/8 (610 x 610 x 149)	500	850	1.0	250	17.0
5	24 x 24 x 11 1/2 (610 x 610 x 292)	1000	1700	1.0	250	32.0 40
6	24 x 24 x 11 1/2 (610 x 610 x 292)	1250	2125	1.0	250	
7	24 x 24 x 11 1/2 (610 x 610 x 292)	1500	2550	1.3	325	
8	24 x 24 x 11 1/2 (610 x 610 x 292)	2000	3400	1.3	325	
9	12 x 12 x 11 1/2 (305 x 305 x 292)	250	25	1.0	250	

HEPA and ULPA filters are typically operated under pressure of approximately 203 mm of water column (8 in. of water column). High operating pressures may rupture the filter. HEPA filters utilized in the nuclear industry have seismic requirements in addition to the performance characteristics discussed above. (EPA, 1991)

Individual HEPA and ULPA filter cells accommodate air floral capacities up to 1.0 sm^3/sec (2000 scfm) (Vokes.

1999). Larger air flow capacities are required for some applications. such as the nuclear ndustry.
To increacre capacity, multiple fiIters are housed in bands or modules vvhich are ducted together. This allows a standard off-the-shell filter unit to be utilized for a variety of applications and air flow rates
(Osborn. 1998). In this type of design, dampers can be used to seal off a portion of the filters for maintenance (Evokes. 1999).

The number of filter cells utilized in a particular system is determined by the air-to-cIoth ratio, or the ratio of volumetric air flow to cloth area. The deletion of air-to-cIoth ratio is based on the particulate loading characteristics and the pressure drop across the filter media. Practical application of fibrous media filters requires the use of large media areas to minimize the pressure drop across the filter (EPA 1998a). The paper and nonwoven filter media used in HEPA and ULPA filters have a larger pressure drop across the filter than the woven fabrics used in bags. For this reasons HEPA and ULPA filters are utilized at lower airflow rates and lower particulate loadings than baghouse designs. As discussed previously, once the air flow rate through the filter system decreases to an unacceptable point, the filter must be replaced (Heumann. 1997).

Operating conditions are important determinants of the choice of materials used in HEPA and ULPA filter cells. Pollutant streams with high operating temperatures, high humidity, or corrosives require special filter media, sealant, materials, and coatings. These special materials increase the cost of the system. (EPA. 1991)

The paper and unproven media used in HEPA and ULPA filters have a significantly higher resistance than the woven fabrics that are used in bag filters. The high efficiencies of HEPA and ULPA filters require that the integrity of the filter seals be maintained. The filter media is subject to physical damage from mechanical stress (Heumann. 1997). Temperatures in excess of 95 °C (200 °F) or corrosive pollutant streams require the use of special materials in the filters which are more expensive (EPA. 1991). Concentrations of some dusts in the filter housing may represent an explosion hazard if a spark is accidentally admitted. Filter media can burn if readily oxidizable dust is being collected (AWMA. 1992). HEPA and ULPA filter systems require high maintenance and frequent filter replacement. Filter life may be shortened in the presence of high temperatures and acid or alkaline participates or gas constituents. High flow rates or dust loads will also decrease the operational life of the filter. HEPA and ULPA filters cannot be operated in moist environments. Hygroscopic materials, condensation of moisture, or tarry adhesive components may cause plugging of the filter media (EPA. 1991).

A specific disadvantage of HEPA and ULPA units is that they may generate a high volume waste product with a low density of pollutant. For HAP applications and chemicals biological, or radioactive toxic PM applications, the filters must be disposed of as hazardous waste. The waste is composed of the wood or metal frames, organic binders and gaskets, glass fiber media, and hazardous contaminants. (EPA. 1991).

What HEPA Filters Can and Cannot Do

Let us take a look at particles which may enter a cleanroom from outside air. If we assume air outside particle concentrations are about one million 0.5 micron and larger particles, it would not be an unreasonable assumption as levels are much higher in many areas of the country. In this case, the number of 0.1 micron particles will be about 35 times as many as for the 0.5 micron particles or about thirty-five million particles per cubic foot. Now let us assume we are using a 99.999% efficient HEPA filter (rated at 0.1 µpoint of least efficiency), we would filter out 34,999,650 particles but 350 one-tenth micron particles would remain. This is the maximum limit for a Class 100 cleanroom! Obviously, we need a number of additional methods to help address the required reductions of particle concentrations.

One way the methods is to use a small percentage of outside makeup air and mix it with recirculated air which gets progressively cleaner, a primary reason along with energy savings to use recirculated air. Another method is to use dual banks of HEPA filters, one set in the make-up handler and a final room set, which is a recommended general practice (using a dual bank also protects the final set from high levels of particle exposure, thus increasing their lifetime and reducing the buildup of pressure drops). At this point, we need to not only note, but also emphasize,that the use of any HEPA filters of less than 99.99% efficiency should never be considered. For even the crudest of cleanrooms, the initial cost savings, if any, will certainly be more than offset by certification costs and the poor results.

A 99.97% efficiency filter is tested with a gross leak measurement indicating that 0.03% of all upstream contamination may be passed through the filter. For a 99.99% filter, the test measures each small area so that no more than .01% of upstream contaminant may be passed in a individual leak. Since most of the filter does not have a leakage rate anywhere near the .01% limit, the result is that the gross leak is far less than 0.01%. Thus, a scanned 99.99% filter is far more than 3 times better than the gross leak tested 99.97% filter, generally on the order of from 1000 to 10,000 times better!.

It is just as important to understand what a HEPA filter cannot do as well as what it can do. No HEPA filter can reduce the amount of contamination introduced downstream of the filter. Repeat: No HEPA filter can reduce the amount of contamination introduced downstream of the filter. While this may seem inherently obvious, it is amazing how many times the excuse that the HEPA filters will take care of it is used!

If the only function of a HEPA filtration system were to provide clean air to the cleanroom, we could pump the room full of clean air and then turn off the filtration system! In fact, ninety percent or better of the function of a well designed cleanroom HVAC system is to remove internally generated contamination and prevent it from adversely affecting the critical product or process. Conversely, delivering clean air to the cleanroom is only ten percent or less of the function. With this in mind, we need to ask, "Where does this internal contamination come from?" ...

- A person sitting or stopped generates about 100,000 particles per cubic ft.
- Sitting down or standing up generates about 2,500,000 particles per cubic ft.
- Walking generates about 10,000,000 particles per cubic ft.
- Horseplay generates about 30,000,000 particles per cubic ft.
- Grinding, sweeping, welding adds billions of particles per cubic ft.
- Two surfaces rubbing generate billions of particles per cubic ft.
- An open, non-airlocked door can add billions of particles per cubic ft.
- Process equipment adds particles
- Process materials add particles
- Maintenance activity adds particles
- Construction residue can generate massive particles throughout the life of the facility!

Thus we cannot depend upon the filtration characteristics of the HEPA to remove the internally generated contamination. We already know that it will only remove a given percentage of upstream contamination. Thus, we must utilize HEPA filters as the valuable tools they are in the cleanroom, but at the same time keep in mind the constraints of their use.

HEPA filters cannot remove contamination introduced downstream of the filter.

Microbially Tested HEPA Filters

Microbially tested simply means that a filter was tested against a particular bacterial, fungal, or viral particle challenge. Many industry and university studies have shown that a HEPA filter provides the same removal efficiency against a viable or a non-viable particulate challenge of the same size. The physical laws at work governing the removal efficiency of a filter media do not discern between a viable and a non-viable particle. The same capture mechanisms apply. Thus, the removal efficiencies for a viable and a non-viable particle are equivalent. The removal efficiency of the HEPA media against a 0.027 micron viral particle is dominated by the diffusion filtration mechanism. This mechanism provides a very effective means of removing very small particles, such as viruses. In fact, the smaller the particle, the higher the removal efficiency due to the diffusion filtration mechanism.

Residential Purposes

Every house with plants, pets or people is automatically polluted. According to the EPA, the air in most homes is at least two to four times more polluted than outside air.

Most of us spend up to 90 percent of our time indoors breathing polluted air and only 10 percent of the time breathing healthy, oxygen-rich outdoor air. The result is that many of us suffer from asthma, allergies and hypersensitivity.

According to the EPA publication The Inside Story: A Guide to Indoor Air Quality, the less fortunate can come down with respiratory diseases, heart disease and cancer after prolonged or repeated periods of exposure to some pollutants.

The American Lung Association reports that 24.7 million Americans have been diagnosed with asthma some time in their lives and that in 1999 alone, close to 2 million emergency room visits were attributed to asthma.

The two primary methods of preventing indoor air pollution are source control and cleaning the air.

Source control: If there are no pollutants, there is no pollution. Unfortunately we live in a very dirty world. On a practical level, source control is as simple as using pump bottles instead of aerosol spray cans, not letting anyone smoke inside the house and exhausting bathroom fans through the roof, not into the attic. It also means waterproofing and ventilating the basement so that it never gets damp and making sure the roof doesn't leak.

Cleaning the air: At the most basic level, the furnace filter takes hunks and chunks out of the air. The American Lung Association recommends upgrading furnace filters to at least the quality of the 3M Filtrete or other electrostatic filter. You also can upgrade to thick media filters, such as the Air Bear, or electronic air cleaners, such as the Trion Max 5 or the Honeywell Electronic air cleaner.

HEPA filtered air cleaners, air purifiers and vacuum cleaners are highly recommended for all allergy and asthma sufferers.

The American Lung Association recommends that proven source control strategies be employed in homes as a primary means of reducing exposure to pollutants, that is, getting at the real source of what causes pollutants and reducing it or removing it. However, physical studies which do not measure health effects do show that certain air cleaners are effective in removing certain indoor air pollutants. Thus, as an adjunct to effective source control and adequate ventilation, highly efficient air cleaners can be useful in further reducing levels of certain indoor air pollutants. More research on the health benefits of air cleaners is needed to provide complete evidence that would better address the circumstances of intended use.

Based on the limited available data, it can be concluded that if allergen sources are present in a residence, air cleaning alone has not been proven effective at reducing airborne allergen-containing particles to levels at which no adverse effects are anticipated. Cats, for example, generally shed allergen at a much greater rate than air cleaners can effect removal. Dust mites excrete allergens in fecal particles in sequestered environments (i.e., within the carpet or the bedding). For individuals sensitive to dust mite allergen, the use of impermeable mattress coverings appears to be as effective as the use of a laminar flow air cleaning unit above the bed. Source control should always be the first choice for allergen control in residences.

The reality in most residences is that total elimination of a pollutant source is not always possible or practical. Individuals with severe allergy and asthma symptoms, whose symptoms are not alleviated by other source control and ventilation strategies, may want to try an effective air cleaner in an attempt to aid in further exposure reduction. Although there is no proven health benefit from such a measure, some individuals report that they perceive air cleaners as useful in improving their health status.

Unfortunately, for residential use, HEPA filters can be noisy when used in air filter systems due to the fan and can be expensive due to electricity costs. To reduce noise, the air intake duct and intake fan is often located outside of a building, oftne on the roof of the building. Replacement filters can also be expensive as HEPA filters are not reusable. Despite this HEPA filters are easily the most effective filters available and their use can improve allergic symptoms dramatically.

HEPA filters (recommended by the Dept. of Homeland Security) are more effective than any other type of air filter at capturing dust, pollen, ragweed, dust mites, mold spores and other allergens.

HEPA Filter Classifications

HEPA and ULPA filters are classified by their minimum collection efficiency. Many international standards and classes currently exist for high efficiency filters (Osborn, 1989). In general, HEPA and ULPA filters are defined as having the following minimum efficiency rating (Heumann, 1997):

HEPA: 99.97% efficiency for the removal of 0.3 µm diameter or larger PM,

ULPA: 99.9995% efficiency for the removal of 0.12 µm diameter or larger PM.

Some extended media filters are capable of much higher efficiencies. Commercially available filters can control PM with 0.01 µm diameter at efficiencies of 99.99+% and PM with 0.1 µm diameter at efficiencies of 99.9999+% (Gaddish, 1989,, Osborn, 1989). Several factors determine HEPA and ULPA filter collection efficiency. These include gas filtration, velocity, particle characteristics, and filter media characteristics. In general, the collection efficiency increases with increasing filtration velocity and particle size. In addition, the collection efficiency increases as the dust cake thickness and density increases on the filter (EPA, 1998a)

HEPA filters fall in a category type that refers to the intended type of application:

Type	Application	Performance
A	industrial, noncritical	> 99.97 % @ 0.3 µm (MIL-STD-282)
B	nuclear containment	> 99.97 % @ 0.3 µm (certified by DOE)
C	laminar flow	> 99.97 % @ 0.3 µm (MIL-STD-282)
D	ultra-low penetration air (ULPA)	> 99.9995 % @ 0.12 µm
E	toxic, nuclear, and biohazard containment	MIL-F-51477, MIL-F-51068 (classified performance)

Cleanrooms that require HEPA filtration will be categorized according to the level of contamination in the room after the air has been filtered out. Cleanrooms fall under one of the following classifications:.

Class	# 0.5 mm particles per ft3	# 5.0 mm particles per ft3	air changes per hour	ceiling filter coverage (%)	air velocity (fpm)	max. vibration (min/s)	temp. tolerance	RH tolerance	approx. capital cost per ft2
office			12-18						$10

100,000	100,000	650	18-30	10					$50
10,000	10,000	65	40-60	30	10		±3.0°F	±5%	$200-250
1,000	1,000	6.5	150-300	50	30-50		±2.0°F	±5%	$350-400
100	100	0.65	400-540	80-100	75-90	500	±1.0°F	±5%	~$1200
10	10	0.065	400-540	100	75-90	250	±0.5°F	±3%	~$3500
1	1	0.0065	540-600	100	90-100	250	±0.3°F	±2%	~$10,000+
0.5	0.5	0.0033	540-600	100	100-110	125	±0.1°F	±1%	~$25,000+

HEPA Filter Testing

Testing of the collection efficiency for HEPA and ULPA filters is performed under clean filter conditions. This is in contrast to continuously cleaned-type filters, such as baghouses, which are tested after reaching a steady-state pressure drop. Cleaned-type filters have nearly constant effluent panicle concentration whereas HEPA and ULPA filters have overall efficiencies which vary with particulate loading. (Heumann, 1997)

The efficiency of each filter is tested by the manufacturer before shipping. The user customarily leak tests the filter and the installation it is in on installation and annually thereafter. For nuclear applications, additional tests are required by the Department of Energy (DOE) and by the owner/operator after installation (Burchsted et at, 19791. There are two separate tests for HEPA and ULPA filter collection efficiencies. HEPA efficiency is rated using a thermal dioctyl phthalate (DOP) test. The test dust for HEPA filters is mono-sized, 0.3 µm diameter, DOP particles, generated by vaporization and condensation. Alternative aerosols can also be used as specified or required for given applications. A photometer measures the particle penetration of the HEPA filter by sensing the scattering of light. ULPA efficiency is tested using a particle counter upstream and downstream of the filter. An atomizer injects a solution of DOP, alcohol, and mineral oil in hexane to generate particles ranging from of 0.1 to 0.2 µm in diameter (Heumann, 1997).

Testing a HEPA filter involves the following requirements:

- Access to the air intake to inject a special type of aerosol whose particle size should not penetrate the HEPA filter
- Mixing the air and aerosol in the upstream air (upstream being the contaminated air on unfiltered side of the HEPA filter)
- Uniform aerosol concentration upstream: making sure that the aerosol particles are uniformly dispersed in the upstream air
- Downstream mixing: Only required at the installation and not at the factory. At the factory, the aerosol exiting the filter is immediately sucked into a particle counter without being dispersed in a room. At the installation, the air needs to be dynamically moved into exhaust ducts to ensure leaked particles are captured.
- Uniform aerosol concentration downstream

Pre-Filters

HEPA and ULPA filters require pre-filtering to remove large PM or for dust concentrations greater 0.03 grams per centimeter squared (g/cm^2) (0.06 pounds per feet squared (Ibs/ft^2)). Pre-filtering may be performed in several stages. Mechanical collectors, such as cyclones or venturi scrubbers may be required to reduce large diameter PM. Standard baghouse or cartridge filters are required to filter out PM greater than 2.5 µm in diameter. (EPA, 1991) In high temperature applications, the cost of high temperature-resistant filter designs must be weighed against the cost of cooling the inlet temperature with spray coolers or dilution air (EPA, 1998b).

Maintaining HEPA Filters

HEPA filters require no cleaning or maintenance to maintain efficiency, and studies have proven that HEPA filters actually increase in efficiency with use over their 3 to 5 year life.

HEPA and ULPA filters are monitored for pressure drop across the filter media. Once the pressure drop becomes unacceptable, the filter must be replaced. The typical pressure drop for a clean filter is 25 millimeters (mm) of water column (1 inches (in.) of water column). An increase of the pressure drop in the range of 51 to 102 mm of water column (2 to 4 in. of water column) indicates the end of the service life of the filter (EPA, 1991, Burchsted et at, 1979). Newer filters are available which have clean filter pressure drops in the range of 6 to 13 mm of water column (0.25 to 0.5 in. of water column) (Burchsted et at, 1979).

The operation of the fiIter may require additonal equipment. Pressure sensors at the inlet and outlet may be required to measure the change in the pressure drop across the fiIter. This not only indicates when the filter should be replaced but also monitors the integrity of the filter system (EPA. 1991). For applications that require a DOP efficiency test to be administered in place, sampling and injection ports and a test apparatus may be required (EPA. 1991). A special fitting may be installed to facilitate bag in/bag out procedures (Vokes. 1999)

In addtition to an increased pressure drop (51 mm to 102 mm of water column), HEPA filters should be immediately replaced whenever it is exposed to:

- Water spray without protection by a demister or any time a filter is exposed to water spray from fire fighting
- Moisture: 95-100% relative humidity at temperatures higher than 130°F
- Hot air: higher than 275°F
- Fire (direct contact)
- Shock pressures greater than 1.7 psig.

Innovations in HEPA Filter Technology

There are technologies that can be applied to existing filter media that would increase the capabilities of the particulate filter. Localized electrostatic charge effects on fiber surfaces are thought to play some part in the filtration process. It is possible to significantly enhance the filter performance of existing media by applying an electric field or static charge effect.

Electrostatic filtration

One technology currently being evaluated is the application of an electric field to the HEPA filter itself. This technology is currently being investigated under a Navy funded research effort by New World Associates in Fredericksburg Va. In typical filters when dust collects on a fiber, it tends to deposit on to the leading edge, or side, of the fiber facing the air stream. Through the application of an electric field, it has been noted that there could be a greater loading of dust on the down stream side of the fiber. Testing to date may support this since a significant increase in filter performance as well as dust load capacity has been achieved. However, as yet no smicrograph images of dendrite deposition have been obtained to determine this. Through the application of this technology drastic improvements to filter life, dust load capability, performance, and significantly reduced maintenance may be possible.

Electrostatic precipitation

Following this same line of thinking, static precipitation technology is advancing and is under investigation. At Porton Down in the UK researchers are working with a low voltage system that they believe could drastically improve particulate filtration. The concept uses an electrostatic precipitator backed up by a HEPA filter. The filter Porton Down is using has a 99% efficiency for a single pass. If used in series with a HEPA filter, the life of the HEPA filter would increase drastically. Current HEPA filters are lasting up to four years in shipboard installations. If this technology were used, it is theoretically possible that the same filters that were installed when the ship was commissioned would be the same filters in use when the ship would be decommissioned. The reason for keeping the HEPA filter in the system is for backup in case the electrostatic filter fails.

A similar approach is being developed by FILT AIR Ltd with its patented air ionizer. The product, known as the Sterionizer, creates a large supply of balanced positive and negative ions. While ionized air plays an important role in other applications such as removing static electricity, improving the quality of air for those who suffer from asthma, and preventing airborne contaminants such as viruses, ionized air also helps to reduce air contamination. Ions clinging to dust particles will weigh down the particles, slow their speed in the airflow, and cause them to stick to the filter media.

Finally, Nano Technology is being used to create new types of materials that either produce smaller fibers or a material with grid-like properties at the submicronic scale. These materials are nonwoven and are generated with processes unlike those used to create typical glass fiber media. The equipment required for Nano Technology manufacturing is rather expensive resulting in a more expensive filter media. Nevertheless, Nano Technology based filter media is catching on and will likely replace convential HEPA filter media in the not so distant future.
Last updated: 27 April 2007

Letter from Leuren Moret to Congressman McDermott concerning HEPA filter failure to protect ...

It will permeate a gas mask filter: particles in the 0.1 micron range will penetrate even a *HEPA* filter (High Efficiency Particulate Airfilter – see Attach. **...**
www.mindfully.org/Nucs/2003/Leuren-Moret-Gen-Groves21feb03.htm - 29k -

Letter from Leuren Moret to Congressman McDermott

with
Declassified memo to Gen. L.R. Groves 1943 – a blueprint for DU

21feb03

"If you can't clean it up, don't use it." Doug Rokke
The Invisible War: Depleted Uranium and the Politics of Radiation 2000

February 21, 2003

The Honorable Jim McDermott, Congressman
Washington State 7th Congressional District
1809 7th Avenue
Suite 1212
Seattle, WA 98101-1399

(206) 553-7170

(206) 553-7175 FAX

RE: Declassified 1943 memo to General L.R. Groves – a blueprint for depleted uranium

Dear Congressman McDermott,

Mr. Joe Pemberton, a lawyer in Bellingham, Washington, has asked me to provide you with scientific information on the critical and overlooked issues of particle size, penetration of gas masks, and mobility of depleted uranium formed under battleground conditions. It is also powerful scientific information to counter false statements recently made by the White House[1] and the DOD[2].

I am writing this letter out of concern for the military personnel who may now be serving on or near the Gulf War battlefields in Iraq and may be quartered in areas already contaminated by depleted uranium munitions. But they are not my only concern. The Gulf War Veterans who are now suffering severe health consequences have also been exposed to depleted uranium, chemicals and biological materials including vaccines while serving in Iraq and Kuwait.

The children and people of Iraq have been the greatest victims from exposure to depleted uranium[15] used in the Gulf War and will continue to be. Over time, they cannot escape the chronic, low level exposure to internal radiation from depleted uranium and its decay products (see Attach. 7) as it cycles and recycles through their environment[3] in water, air and food products.

Depleted uranium dust will continue to be an extreme hazard to soldiers, civilians, populations in countries downwind[6,8], and the environment as a radiological contaminant to all living systems for ten half-lives or 45 BILLION years.

I am a former Lawrence Berkeley Lab and Lawrence Livermore Lab scientist, and now work with a group of independent scientists called **the Radiation and Public Health Project**[4]. Together this group has written ten books on the health effects of low level radiation. Presently I am writing a science report on depleted uranium for the United Nations Human Rights Subcommission, now investigating the illegality and use of depleted uranium munitions. I have written the Foreword (Attach.1) to ***Discounted Casualties: The Human Cost of Depleted Uranium*** by Akira Tashiro[5].

Attached (Attach. 2) is a declassified memo to General L. R. Groves, director of the Manhattan Project, dated October 30, 1943. Major Doug Rokke provided me with this memo. It summarizes a report written by Manhattan Project physicists Drs. James B. Conant, A. H. Compton and H.C. Urey on the dissemination of very fine radioactive material as a method of warfare. It is a "blueprint" for depleted uranium as it has been used in Iraq, Kuwait, Kosovo, Bosnia and Afghanistan during the past decade. The memo details the use of very fine and superfine particles of radioactive materials as a military weapon. Depleted uranium, produces very fine and superfine particles in large amounts as it burns. The 1943 memo outlines what was known in 1943 and below are my comments:

- **A gas warfare instrument**: the memo indirectly referred to fission products from Fermi's nuclear pile or radioactive waste like depleted uranium. The pyrophoric effect of depleted uranium, which spontaneously burns when heated to 170 C (once it is fired) and on impact, effectively forms very large numbers of extremely fine (0.1 micron) and submicroscopic particles as small as 0.001 micron or 10 Ångstroms (see Attach. 3 - Chart "Characteristics of Particles and Particle Dispersoids") as described in the memo. Particles in this size range behave like a gas when inhaled, disperse in the lungs to the blood lung barrier where the white blood cells (greater than 7microns in diameter) engulf the tiny particles of depleted uranium and carry them throughout the body. Once these particles have been engulfed by blood cells or lodged in tissues, they may not be detectable in the urine. Contaminated personnel will take the depleted uranium home, deposited in tissues throughout their bodies.

There is no known treatment for exposure.

- **It will permeate a gas mask filter**: particles in the 0.1 micron range will penetrate even a HEPA filter (High Efficiency Particulate Airfilter – see Attach. 4 - HEPA chart) in large numbers. The filters in gas masks issued to military personnel are much less efficient than HEPA filters. There are 1 billion particles of 0.1 micron diameter in a cubic meter of normal air. It is clear that a man (without a gas mask) breathing at a normal rate (about 28 cubic meters per day[6]) and retaining 75% of the very fine particulate matter in the respiratory system[6] will inhale very large numbers of very fine particles in a short time period.

In a day an average man would normally inhale 28 million particles in the 0.1 micron range through a gas mask with HEPA filters. It would take one billion fine particles to fill the period at the end of this sentence. On the battlefield during live fire, the high concentrations of fine and very fine depleted uranium particles could increase the numbers inhaled in the small particle range by magnitudes.

The gas masks issued to military personnel now deployed to the Gulf Region are defective and do not provide even a minimum of protection to personnel. Recently I went on a speaking tour in 3 northeastern states with Major Doug Rokke, January 25-February 1, 2003. In nearly every talk we gave, a National Guardsman or other military person would tell us that their masks fell off when they tilted their heads.

Air filters in gas masks also fail as they are wetted by moisture from breathing or are used in the rain.

There is no possible protection from exposure to very fine particles of depleted uranium through filtering of air.

- **As a terrain contaminant:** the dispersal of very fine particles of depleted uranium will contaminate the terrain and deny access to either side except at the risk of exposure. That includes civilians and animals who may live there after the battle. The half-life of depleted uranium – 4.5 billion years – leaves the contaminated terrain radioactive forever.

Small particles less than 1 micron in diameter do not settle from the air (see Attach. 3 – Chart "Characteristics of Particles and Particle Dispersoids") but become incorporated into atmospheric dust (see Attach. 5 - Chart "Natural Aerosols") and are transported around the earth until they are removed ("rainout") by rain, pollution or snow[3]. Seasonal climate change, agricultural activities, fires and other natural and man-made disturbances will continue to remobilize particles in the upper dust level contaminating terrains off the battlefield.

Weathering of larger particles of depleted uranium deposited on the battlefield[7] will contribute to concentrations of depleted uranium fine and superfine particles in the air and upper dust level.

Air monitors in Hungary[8] and Greece during bombing in Kosovo and Bosnia measured Uranium 238 carried by the wind from the battlefields. Seasonal fluctuations of depleted uranium particles in the air have been reported in Kuwait[6].

- **Water and food contamination**: the depleted uranium dust will cycle through the environment both on and off the battlefield contaminating water supplies and food. Food grown in contaminated areas will be transported to markets and contaminate populations and areas far from the battlefields. Wind, water, birds[9] and animals who transport the depleted uranium in their droppings, slowly contaminate wider and wider areas.

- **Internal contamination**: inhalation of very fine depleted uranium dust particles is extremely damaging to the respiratory tract and will get into the blood stream where it is carried by blood cells and contaminates tissues throughout the body. These "hot particles"[10] will continue to emit alpha and gamma radiation (see Attach. 6 - photo "Hot particle in lung tissue") as they travel throughout the body or where they rest in tissue. After the Uranium 238 nucleus decays, the radioactive daughter product which forms (see Attach. 7) will continue to decay to other isotopes as many as four times. This will increase the level of radioactive exposure by magnitudes. Depleted uranium particles lodged in tissue will decay and continue emitting higher levels of radioactivity from daughter isotopes into the surrounding tissues.

SYNERGISTIC EFFECTS: The health effects from exposure to a combination of radiation, chemicals, and biological agents was not addressed in this WW II memo. This is a critical issue on the battlefield and should be considered in studies of Gulf War Illness. The combination of radiation with heavy metals, chemicals and biological toxins accelerate and increase the adverse health effects of exposure. The effects are unknown since very little research exists in this field[11].

THIS IS AN ISSUE WHICH SHOULD BE CONSIDERED IN FUTURE CONFLICTS SUCH AS THE PLANNED BOMBING OF IRAQ.

MEASUREMENTS OF DU IN TISSUES FROM 71 DEAD RESIDENTS OF BASRA:

Dr. Hari Sharma, a radiochemist living in Canada and member of the Radiation and Public Health Project, has measured depleted uranium levels in the tissues of 71 residents of Basra who died after the Gulf War from cancers[12]. They were in the age range of 35-50 years. He found high concentrations of depleted uranium in tissue samples from these individuals. The levels were about the same throughout the tissues, suggesting that very fine particles were transported in the blood and deposited or lodged throughout the body.

WORLD TRADE CENTER AIR STUDIES:

Dr. Thomas Cahill, Emeritus Professor of Physics and Atmospheric Sciences at the University of California at Davis, conducted an independent study of the air around Ground Zero at the World Trade Center after the 9/11 disaster[13]. Using very sophisticated monitoring instruments[14] which detect very fine and ultra fine particles, Cahill and his group monitored the smoldering pile at the WTC for 5 months following the disaster from one mile north of the center. They measured concentrations of particles in six size ranges from 2.5 microns to 0.09 microns[13]. They reported the highest concentrations of very fine particles of metals ever reported in the US[13], and unprecedented numbers of very fine and super fine particles[13]. This air monitoring study of the WTC provided new information about very fine and superfine particles which have rarely been studied. Burning metals and other materials at high temperatures generate very large amounts of very small particles. For this reason depleted uranium which has burned is particularly hazardous.

The EPA has verified that depleted uranium was in the plane that crashed into the Pentagon on 9/11 [18,19] and that the crash site was contaminated. Residents of New York City detected radiation on hand held geiger counters at the WTC site. The EPA not only failed to protect emergency response personnel at both sites, but did not report or measure[13] concentrations of very fine particles at any of the 9/11 plane crash locations. These are the most hazardous to health, and many personnel who worked at the crash sites are now very ill.

Dr. Cahill also studied the Kuwaiti oil field fires following the Gulf War.

ECRR: RELEASED JANUARY 30, 2003

A new report from the European Parliament has been released "2003 Recommendations of the European Committee on Radiation Risk: Health Effects of Ionising Radiation Exposure at Low Doses for Radiation Protection Purposes" Regulators' Edition: Brussels, 2003 [10]. The report was written by 46 international scientists and has over 550 references to epidemiological studies which include nuclear site leukemias, Chernobyl infants, minisatellite mutations, weapons fallout cancers, DU Gulf Veterans, and Iraqi children.

The report concludes that the International Committee on Radiation Protection (ICRP) determined international standards for risk and dose effects from studies on A-bomb survivors which were based on high dose, external, acute exposures. The ICRP model only considered cancer as a health risk associated with radiation exposure. The ICRP model, using "bathtub" chemistry, "steam engine" physics, and deceptive reporting, produced faulty and fraudulent estimates of risk and dose effects. Additionally, because the ICRP model is based on acute, high dose, external exposure it cannot accurately determine risks or dose response for internal, chronic, isotopic exposures. For this reason, the ICRP and ECRR models are mutually exclusive.

This new ECRR report based on epidemiological studies, concludes that the health effects of low level radiation exposure have been underestimated by the ICRP model by 100-1000 times. It also includes other health effects due to radiation exposure from global weapons fallout. In addition to cancer it estimates the number of foetal deaths, infant mortality, and predicts "a 10% loss of life quality integrated over all diseases and conditions in those who were exposed over the period of global weapons fallout".

The committee concluded that underestimates of risk and dose effects for depleted uranium exposure could be very great since the effect at the cell level may be very different than other types of radiation exposures. For this reason the health effects of depleted uranium exposure in Gulf Veterans will be investigated in depth by this committee and will be presented in a new report.

Internal exposure to depleted uranium is a "novel" exposure to an altered form of natural isotopes. The size, shape, surface texture, density, chemical composition and other physical and chemical factors of the particles greatly affect the health impact and damage to the cells of any biological system from depleted uranium exposure. Particle size may be the most overlooked and one of the most important characteristics of depleted uranium dust formed on the battlefield. After burning, depleted uranium is altered both physically and chemically and estimates of risk to health and dose effects cannot be based on previous studies of naturally occurring uranium. In the Research Report Summaries[7] of depleted uranium studies done for the military between 1974 and 1999, they clearly provide information and concerns in these studies about the hazards of depleted uranium both to health, exposure on the battlefield and damage to the environment. This summary is well worth reading as it provides a timeline of the military politicizing decisions on the use of depleted uranium over 25 years. For example, in a 1980 Army report[17]:

> This report provides an excellent history of the logic behind the Army's decision to use DU as a kinetic energy, armored-piercing munition. DU's final selection over tungsten was based on several reasons, including the lower initial cost of the penetrator itself and its better overall performance. DU and tungsten were rated even for "producibility". Tungsten had the advantage for safety, environmental concerns, and deployment.

RADIATION RESPECTS NO BORDERS

Depleted uranium is being used as an effective munition on the battlefield and as a radiological weapon to destroy the genetic future of the Iraqi people15. Before the Gulf War, Iraq was the most developed and advanced country in the Middle East[16]. Writing, religion, poetry, music and science began in the region which includes Iraq, the Cradle of Civilization. The ability of the Iraqi people has been recognized for millenia. The Iraqi people are more feared than Saddam Hussein by the US. Their talent for creativity, ability to be self-determined, and their natural resources have made them the target of the US Government, US oil companies and the Department of Defense.

In November of 1991, Richard Berta, the Western Regional Inspector for the Department of Energy who was based at the Lawrence Livermore Lab where I worked, told me: "The Pentagon exists for the oil companies…"

The use of depleted uranium by the Department of Defense has created a slow Chernobyl in the Middle East.

With my best wishes and hopes that this radiation nightmare will finally come to an end, and with thanks for your efforts to move the issue into the light,

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ATTACHMENTS:

Attachment 1: "Forword" by Leuren Moret to ***Discounted Casualties: The Human Cost of Depleted Uranium*** by Akira Tashiro, Chugoku Shimbun (2001).

Attachment 2: Declassified memo to General L.R. Groves, Director of the Manhattan Project, October 30, 1943. Source – US Army Major Doug Rokke

Attachment 3: TABLE: "Characteristics of Particles and Particle Dispersoids" from the **HANDBOOK OF CHEMISTRY AND PHYSICS** 53rd Edition. This chart provides the particle range which is very wide for metallurgical dusts and fumes, a range from 100 microns to 0.001 microns (10 Angstroms). Particles smaller than 0.1 microns will coagulate and form larger particles, but the greatest number or population of particles will be in the 0.1 micron range (see Chart "Natural Aerosols"). This particle range is smaller than blood cells, bacteria, pollens, spores and other typical air contaminants. Very fine particles are extremely hazardous to health because they are carried by the blood throughout the body. The rate of radiation exposure from one very small particle can be more than is allowed for a whole body exposure in one year (see photo "Hot particle in lung tissue").

Attachment 4: CHART: "Penetration of a HEPA filter as a function of particle size" from 18TH DOE NUCLEAR AIRBORNE WASTE MANAGEMENT AND AIR CLEANING CONFERENCE, Baltimore 1984. Experimental penetration of particles through a HEPA filter – determination that approximately 0.1% in the 0.1 micron particle range will pass through the filter. If there are 100,000 particles 0.1 micron in diameter per cubic centimeter of air, then 120 per cubic centimeter of air will pass through a HEPA filter. **In one day an average man will inhale 28 million particles in the 0.1 micron range through a HEPA filter**.

Attachment 5: CHART: "Natural Aerosols" from **ENCYCLOPEDIA OF SCIENCE & TECHNOLOGY** 7th Edition (1992), McGraw Hill.
This chart provides the average size distribution for natural aerosols in atmospheric dusts. The largest population or number of particles in an aerosol dust is in the 0.1-0.01 micron range. Depleted uranium particles in this size range will be incorporated in atmospheric dusts and will travel indefinitely, transported by winds.

Attachment 6: PHOTO: "Hot" or radioactive particle in lung tissue" photo by Del Tredici, **Burdens of Proof** by Tim Connor, Energy Research Foundation (1997). This is a photo of a "hot particle", in this case a 1 micron particle of plutonium, and shows the alpha tracks emitted from that particle in one year.

Attachment 7: **Van Nostrand's Scientific Encyclopedia** 5th Edition (1976) Decay paths for natural uranium – Table 1 The Uranium Series, and Table 3 The Actinium Series. The decay paths for uranium are very complex but decay through a number of steps before they become stable and are no longer radioactive. Each of these steps produces a radioactive daughter product which will be more radioactive than the original uranium atom.

SOME MORE IDEAS OF WHAT CAN GO WRONG WITH HEPA FILTERS: (FROM THE U.S DEPARTMENT OF ENERGY)

http://www.hss.energy.gov/csa/csp/hepa/lessons.cfm

HEPA Related Lessons Learned

Identifier: 2004-RL-HNF-0041

Date: 10/13/2004

Title: Vital Safety System Filter Degradation

Summary: Contractors must institutionalize site-wide processes/programs that guide facility management in determining operability of safety class equipment such as HEPA filters.

Potential age-related degradation of two ventilation filters at PFP resulted in an Unreviewed Safety Question (USQ).

Identifier: 2004-LL-NUCL-0002

Date: 9/30/2004

Title: Age Degradation of High Efficiency Particulate Air Filters

Summary: Implementation of new information, such as the tensile strength testing results published in the recent version of the DOE Nuclear Air Cleaning Handbook, can have a significant impact on the validity of design and safety basis assumptions. Therefore, prompt communication and analysis of new information, such as was performed by DOE and PNNL is critical to promptly maintain the safety basis of a nuclear facility such as the RPL.

Identifier: 2004-SR-WSRC-0039

Date: 9/14/2004

Title: Effective Team Approach to Handling and Removal of UF-6 Line

Summary: During deactivation of the 247-F Facility at SRS, uranium hexafluoride (UF_6) process lines needed to be removed. The project team evaluated the hazards and devised a plan to eliminate or mitigate each hazard; one process line was plugged with material and blanked over 10 years ago. Project personnel employed a "team hazards analysis" approach using the Automated Hazards Analysis (AHA) program. Team members from Industrial Hygiene, Engineering, Radiological Controls, and Project Management participated in briefings and conducted mockup training. This team AHA approach led to the successful removal of the UF_6 and associated process lines.

Identifier: 2004-RL-HNF-0023

Date: 6/21/2004

Title: HEPA Filter Bank Left in Service without Being Tested

Summary: A HEPA filter bank at the Plutonium Finishing Plant was found in service following installation of new filters before the filter bank had been leak tested and declared operable by the Surveillance Shift Manager (SSM). Imprecise and incomplete communication between the Person-in-Charge (PIC) and the SSM did not allow the SSM to clearly recognize that the filter dampers were open. A Technical Safety Requirement (TSR) was violated because the SSM did not know existing plant conditions.

Identifier: 2004-RL-HNF-0021

Date: 5/28/2004

Title: Fissile Material Stored in Unapproved Location

Summary: Transuranic (TRU) fissile waste material was stored in an airlock that was approved by criticality safety but was not covered by the facility safety basis. Two separate people did not properly apply the complex Unreviewed Safety Question (USQ) screening and evaluation process. Plant personnel did not recognize this vulnerability even after two previous events related to storage in airlocks.

Identifier: 2004-SR-WSRC-0014

Date: 3/30/2004

Title: Radiological Operations Support Center - Best Practice

Summary: At the Savannah River Site (SRS), the Radiological Operations Support Center (ROSC) has been established to provide a centralized resource for practical applications of the "as low as reasonable achievable" approach to work as well as a clearinghouse of information. The ROSC consists of mutually supporting groups targeted at efforts in waste minimization and pollution prevention, radiological hazard reduction and safe, cost effective operations.

In 2003, the ROSC earned an SRS Facility Evaluation Board (FEB) Noteworthy Practice communicated during a FEB evaluation, indicating that this is a particularly effective and efficient, innovative method that has been developed and implemented to meet SRS business needs.

Identifier: 2003-RL-HNF-0004

Date: 2/21/2003

Title: Incorrect Volume of Oil in Hot Cell Window Used in Safety Basis Calculations

Summary: An Unreviewed Safety Question (USQ) was declared at the Waste Encapsulation and Storage Facility (WESF) because the hot cell shield windows contain more oil than is assumed in the WESF Basis for Interim Operations (BIO). The incorrect amount of oil was obtained from the fire hazard analysis (FHA) but was not verified by the BIO authors before using it in calculations of combustible loading.

Identifier: Y-2002-OR-BJCX10-1201

Date: 12/13/2002

Title: Site Contamination Due to HEPA Filter Changeout

Summary: When performing HEPA filter changeouts, the hazard analysis should consider environmental protection as well as worker protection. This is especially important for old and deactivated facilities.

Identifier: 2002-RL-HNF-0059

Date: 10/17/2002

Title: Controlling One Hazard Introduced Another

Summary: Occasionally controls implemented to mitigate hazards identified during pre-job planning can introduce other unidentified hazards into the job. Those additional hazards must be adequately controlled to maintain a safe work environment.

Identifier: 2002-RL-HNF-0037

Date: 7/1/2002

Title: Adequacy of HEPA Filter Testing

Summary: Adequacy of downstream aerosol mixing on many older HEPA filter systems has neither been assured through system design nor validated through acceptance testing. Therefore, incorporating compensatory measures into selected test procedures may be necessary to minimize potentially overstating filter performance and to increase confidence that in-place leak tests can reliably identify adverse filter performance on less than ideal HEPA system designs.

Identifier: 2002-RL-HNF-0027

Date: 5/30/2002

Title: ALARA Good Work Practices

Summary: Many techniques are available for making radiological work safer and more efficient. This document contains brief descriptions of some collected from past reports from the Hanford ALARA Center. They are compiled here for introduction into the DOE Lessons Learned process.

Identifier: 2002-OH-WVNS-004

Date: 5/5/2002

Title: Radioactive Contamination from the Main Plant Stack

Summary: Excess moisture on a systems high efficiency particulate air (HEPA) filters may allow migration of radioactive contamination through the filters. Engineered systems need to be in place, to ensure moisture build-up is minimized. Any changes, even temporary, to the operational parameters must be incorporated into operator round sheets used to monitor plant conditions. It is also important that even temporary changes (not only physical changes) are incorporated into plant procedures. Further, personnel needs to understand the interaction of environmental changes along with changes in operational parameters during initial design and later modifications.

Identifier: L-2002-OR-BJCX10-0301

Date: 3/5/2002

Title: Pressurization of Drain Trap

Summary: Whenever performing a design or design change on any vessel configuration, assure inadvertent pressurization of the vessel is considered in the design.

Identifier: 2002-OH-WVNS-003

Date: 2/28/2002

Title: Flame Observed During HEPA Filter Aerosol (PAO) Challenge Testing

Summary: To help ensure the safety of personnel and the safe operation of potentially dangerous equipment, it is extremely important that manufacturer's operations and maintenance instructions are strictly adhered to. Manufacturers instructions may include: periodic maintenance and testing of equipment, training of personnel, equipment configuration, and proper operating parameters (ie. air pressure, temperature, etc.). In addition, when manufacturers make administrative changes to the operation and/or equipment modifications, site specific operational procedure changes may be necessary.

Identifier: 2001-RL-HNF-0043

Date: 12/3/2001

Title: HEPA DP Gauge Piping Not Fully Tested after Installation

Summary: Acceptance tests for installation of new equipment should include full loop tests for instruments with a potential for sensing line errors. Similar care should be exercised following system modifications or major repairs having a potential to affect sensing line configuration.

Identifier: ALO-AO-BWXP-PANTEX-2001-0013

Date: 10/11/2001

Title: Potential Safety Concern Due to HVAC Filter Change Disturbance of Beryllium Contamination

Summary: Regardless of our intentions, good communications are essential to understanding requirements and properly accomplishing tasks.

Identifier: 2001-707/776/777PROJECT-01

Date: 10/5/2001

Title: Odorous Full-Face Respirators

Summary: Always perform a complete pre-use inspection before donning your respirator. If you smell an irritating odor coming from the respirator, reseal it along with the laundry date tag in the bag it came in, and turn it over to your Industrial Hygiene and Safety (IH&S) representative.

Identifier: L-2001-OR-BWXTY12-0902

Date: 9/17/2001

Title: Use of Portable Vacuum Cleaners Not Intended for Hazardous Materials

Summary: Portable vacuum cleaners may not be acceptable for use in clean-up of hazardous materials.

Identifier: 2001-NV-NTSWSI-001

Date: 8/22/2001

Title: Airborne Lead Detected in Indoor Firing Range

Summary: Security companies that operate indoor firing ranges must ensure the ventilation system is operational during firearms training activities and that routine clean up of lead dust occurs.

Identifier: 2001-OH-WVNS-ARPR-006

Date: 8/20/2001

Title: Waste Characterization

Summary: Sampling activities, such as determining the number of waste streams present, the number of samples required and the containers required for the waste materials for waste characterization should be performed prior to the start of a Project. Because these activities weren't completed until after the commencement of the dismantlement activities, the Acid Recover Pump Room (ARPR) project was delayed, both in the packaging of the waste materials which were being generated and the sampling which was required to perform characterization.

Identifier: 2001-OH-WVNS-ARPR-005

Date: 8/20/2001

Title: Electronic Dosimetry

Summary: Electronic dosimetry can save time that would otherwise be spent attempting to read a direct reading dosimeter while in a work area.

Identifier: 2001-OH-WVNS-ARPR-004

Date: 8/20/2001

Title: Dedicated Personnel/Multiple Entries allowed consistency on the Project

Summary: Keeping personnel consistent through the entirety of an evolution, can reduce the amount of pre-job briefings having to be held and can make the completion of the operation much easier to accomplish.

Identifier: 2001-OH-WVNS-ARPR-003

Date: 8/20/2001

Title: Placement encapsulate any remaining radioactive particulate

Summary: Grouting the floor of the Acid Recovery Pump Room (ARPR) provided a smooth surface, assisted in encapsulating remaining radioactive particulates and Asbestos Containing Material (ACM) within the work area.

Identifier: 2001-OH-WVNS-ARPR-002

Date: 8/20/2001

Title: Polymeric Barrier Seal (PBS) Encapsulant reduces the level of Asbestos Containing Material

Summary: Reduction of Asbestos Containing Material (ACM) and radioactive particulate can be achieved by using an encapsulant in the area. This can eliminate unacceptably high Derived Air Concentration (DAC) levels within the area.

Identifier: 2001-OH-WVNS-ARPR-001

Date: 8/20/2001

Title: Roller System Utilized to Remove Waste

Summary: A roller system was utilized to remove waste from the Acid Recovery Pump Room (ARPR) clean out work area. This system enabled D&D Operators to move the containers with ease, as well as contributing to the ALARA (As Low As Reasonably Achievable) concept requiring D&D personnel to spend minimum time in a radiation the area.

Identifier: 2001-RL-HNF-0030

Date: 8/16/2001

Title: HEPA Vacuums Draw Current above the Rating of Power Cords

Summary: Euroclean Model UZ948 HEPA vacuum cleaners draw current above that for which the cords and plugs are rated.

Identifier: ANLW-2001-DI# 2000-0112

Date: 4/3/2001

Title: Solid-State Relay Failure Mode Considerations

Summary: A common failure mode for solid-state relays (SSR) is shorted or in the "ON" state. When used as part of a heater control circuit, the consequences of such a failure and the resulting uncontrolled temperature increase must be evaluated not only during the design phase, but also during subsequent modifications that affect the established design criteria.

Identifier: 2001-RPP-CHG-IB-01-05

Date: 3/22/2001

Title: HEPA Filtered Exhausters Air Flow

Summary: Portable HEPA filtered exhausters used for ventilation may be capable of generating air flows higher than the rated flow of the HEPA filters in the exhausters.

Identifier: 2001-OH-WVNS-006

Date: 2/19/2001

Title: Mask Protection Factor Exceeded During D & D Work

Summary: When planning work in areas with high concentrations of contamination that can become airborne, it is important to identify the levels of contamination prior to work starting and to continuously monitor personnel working in these conditions. Always calculate with a conservative safety factor when determining the required PPE.

Identifier: 2001-RF-KH-0003

Date: 12/14/2000

Title: Beryllium Contamination from Equipment Removal

Summary: Prior characterization of beryllium contamination is not sufficient to predict the generation of airborne beryllium contamination when the work involved may uncover or disturb hidden contamination. Therefore respiratory protection must be used if there is any question.

Identifier: L-2000-OR-BJCY12-0802

Date: 8/24/2000

Title: Work Planning and execution need close attention to detail

Summary: Work planners need to be familiar with the exact configuration of the work site. All people involved in job planning and execution need to share the same understanding of work conditions, requirements, and definitions. In this instance, misunderstood details and incomplete communications led to a confinced space entry violation.

Identifier: 2000-CH-BNL-EP-001

Date: 7/25/2000

Title: Multiple Work Permits Needed on Multi-Work Crew Jobs

Summary: Some work permit jobs require several service providers or trades phased over a period of time. For jobs like this, the original work permit should be split into multiple work permits to keep the hazards, work controls, and pre-job briefing information well organized by job phase or job crew. The multiple work permits can utilize the original work permit number with suffix letters (A, B, C, etc.) attached for tracking purposes

Identifier: OH-MD- LL00-170

Date: 7/6/2000

Title: Respirator Failed During Operations

Summary: PPE should be carefully inspected prior to use.

Identifier: 2000-RL-HNF-0022

Date: 6/20/2000

Title: USQ from Inability to Test HEPA Filtration Efficiency

Summary: Assumptions in Safety Analysis Reports (SAR) for High-Efficiency Particulate Air (HEPA) filtration efficiency during design basis accidents should be consistent with values actually achievable during periodic testing.

Identifier: 2000-RL-HNF-0017

Date: 5/22/2000

Title: Procurement, Handling, and Storage of Equipment and Components

Summary: Purchased equipment and components should be packaged, stored, and handled to the same level of requirements imposed on suppliers to prevent damage, deterioration, or contamination of the items before they installed.

Identifier: 2000-LA-LANL-ESH7-0004

Date: 3/28/2000

Title: Recognizing What is Included in Your Work Scope

Summary: Because certain types of work such as research and development, decontamination and decommissioning, and work with legacy materials inherently involve unknown hazards, work planners should consider establishing hold points for these types of work activities to ensure that workers periodically evaluate current conditions against established hazard controls and work authorization documents.

Identifier: 2000-LA-LANL-ESH7-0003

Date: 1/21/2000

Title: Glovebox Maintenance and Control Issues

Summary: Glovebox gloves should be routinely inspected regardless of location or frequency of use.

Procedures should address actions for unanticipated conditions discovered during work or at startup.

Line and facility ownership of equipment should be formally documented to prevent loss of information through reorganizations or reassignments.

Identifier: Y-1999-OR-BJCETTP-0702

Date: 7/14/1999

Title: Respirator Protection Factor for Lead Exceeded

Summary: Change control processes should ensure that a hazard assessment is conducted any time the work process changes.

Hazard controls should include personal protective equipment that protects workers against the highest potential air concentrations reasonably expected until air monitoring verifies that engineering controls are adequate.

Indicators should be visible to workers so they can tell when ventilation equipment malfunctions.

Identifier: 1999-OH-WVNS-011

Date: 5/10/1999

Title: Potential Fire Hazard Associated with Polyalphaolefin (PAO)

Summary: Only one procedural barrier exists that prevents possible fire with personnel injury or equipment damage when performing PAO testing with a NUCON model *F-1000-DG-F* Thermal Generator. Site/facility operating procedures need to comply with vendor recommendations. A new hazard analysis needs to be performed if a different aerosol is used.

Identifier: L-1998-OR-BJCETTP-0703

Date: 7/27/1998

Title: Personnel Contamination Event at ORNL

Summary: The failure to periodically check high-efficiency particulate air (HEPA) filters for contamination, when on the discharge of a diaphragm pump, can result in the HEPA filter becoming saturated and contamination exiting the barriers setup to contain it. It should also be noted that a diaphragm can leak through and remain operational.

Identifier: L-1998-OEWS-11

Date: 4/6/1998

Title: Preliminary Notice of Violation (PNOV) at LLNL for Failure to Protect Workers

Summary: Failure to implement radiological protection requirements and provide the quality controls necessary to protect workers involved in High Efficiency Particulate Air (HEPA) filter shredding operations or to take timely and appropriate corrective actions when deficiencies are noted, can result in a Price Anderson Amendments Act (PAAA) Preliminary Notice of Violation (PNOV).

Identifier: 1998-EM-HQ-0001

Date: 1/14/1998

Title: Nuclear Ventilation HEPA Filter Degradation

Summary: The fiberglass "paper" media that provides filtration in ventilation filters is subject to embrittlement with age. This is of concern because many old filters remain in service in DOE Nuclear facilities where they provide an important filtration safety function under normal operating and accident conditions.

Identifier: Y-1997-OR-LMESCENT-0601

Date: 6/30/1997

Title: Failure to Recognize Changed Conditions Leads to Injury and Contamination

Summary: Hazard analysis must be an ongoing process that continues throughout the duration of a project. Supervisors and workers must recognize changes in job scope, work practices, methods, or operating conditions. Such information must be communicated to safety and health personnel for re-evaluation in order to determine whether new or modified controls will be necessary. Work plans or activity hazard analyses should contain provisions to temporarily suspend work under such conditions.

Identifier: 1996-DOE-DP-0001

Date: 10/31/1996

Title: Radiation Exposure from Low-Energy Photons

Summary: Radiological controls inspector coverage is required for specific work activities where there is a high potential for unanticipated exposure. In order to minimize exposure, the use of proper protective equipment for both the inspector and those performing assigned tasks must be thoroughly evaluated during job planning. Remember, inspectors can potentially become exposed to the same radiation sources as those performing the assigned work. Also, when low-energy photon activity from plutonium is present, electronic dosimeters must be used, as this low-energy activity is not within the sensitivity range of self-reading dosimeters (SRDs).

Identifier: INEL #96251

Date: 6/22/1996

Title: Re-Use of Chemical/Combination Respirator Cartridges

Summary: To safeguard the health and safety of respirator users, facilities need to verify that service received from respirator vendors is adequate and appropriate. Facilities need to verify that respirators issued to workers are clean, in good repair, and that cartridges/canisters supplied by the vendor provide adequate protection in hazardous atmospheres.

Identifier: Y-1996-OR-LMESCENT-0502

Date: 5/23/1996

Title: Contamination Incident and Price-Anderson Amendments Act Non-Compliance

Summary: Clear and timely Contractor-Subcontractor communication is vital to minimize the potential for violations of work permits and radiological worker exposures. Not only are safety and health consequences at risk, but failure to properly communicate performance expectations could lead to fines or other penalties to the company under Price-Anderson Amendments Act (PAAA) provisions. Additionally, the work control agreements between safety and health professionals familiar with Contractor protocols and Subcontractor personnel are essential to safe and efficient work performance.

Identifier: L-1995-OR-LMESX10-1201

Date: 12/21/1995

Title: Ventilation Filter Bypass Through Drain Line

Summary: Facility management should assess a facility's High Efficiency Particulate Air (HEPA) ventilation system configuration against the testing method used to challenge and measure that system's performance.

Identifier: 1995-RL-WHC-0023

Date: 5/4/1995

Title: Unplanned Exposures to Lead (Pb)

Summary: Lead is one of several heavy metals that present a hazard to workers at DOE facilities. Frequent exposure to levels above permissible limits can result in a body burden that can cause long term health problems.

Jobs that have the potential for creating airborne materials must be carefully analyzed to ensure adequate respiratory protection is provided to the workers. In the case at Hanford the powder actuated tool was evaluated purely for its physical hazards. No one had considered the fumes from the ignition of the gunpowder as a potential source of exposure.

The other two cases resulted from inaccurate estimates of the levels of dust that would be generated.

People of the bomb

By Hugh Gusterson
We have had the bomb on our minds since 1945. It was first our weaponry and then our diplomacy, and now it's our economy. How can we suppose that something so monstrously powerful would not, after forty years, compose our identity? -E. L. Doctorow

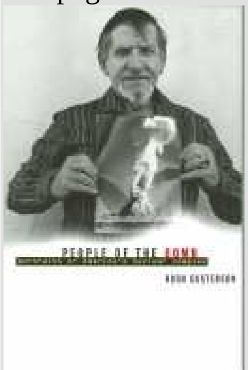
This book tells the story of how-like it or not, know it or not-we have become "the people of the bomb." Integrating fifteen years of field research at weapons laboratories across the United States with discussion of popular movies, political speeches, media coverage of war, and the arcane literature of defense intellectuals, Hugh Gusterson shows how the military-industrial complex has built consent for its programs and, in the process, taken the public "nuclear."

People of the Bomb mixes empathic and vivid portraits of individual weapons scientists with hard-hitting scrutiny of defense intellectuals' inability to foresee the end of the cold war, government rhetoric on missile defense, official double standards about nuclear proliferation, and pork barrel politics in the nuclear weapons complex. Overall, the book assembles a disturbing picture of the ways in which the military-industrial complex has transformed our public culture and personal psychology in the half century since we entered the nuclear age.

Hugh Gusterson is associate professor of anthropology and science studies at the Massachusetts Institute of Technology and professor of public policy at the Georgia Institute of Technology. He is the author of Nuclear Rites: A Weapons Laboratory at the End of the Cold War (1996) and coeditor of Cultures of Insecurity: States, Communities, and the Production of Danger (Minnesota, 1999). Lynne Cheney's American Council of Trustees andAlumni named him one of the most dangerous intellectuals in the United States today.

More details

People of the bomb: portraits of America's nuclear complex
By Hugh Gusterson

Published by U of Minnesota Press, 2004
ISBN 0816638608, 9780816638604
312 pages


http://books.google.co.za/books?id=iHJRW0GI31MC&dq=HEPA+filters+nuclear&q=HEPA#search_anchor
Page 210
Lab management promised that the incinerator, which would be fitted with high-efficiency particulate air (**HEPA**) filters to trap escaping particles, **...**
Page 215
At the hearings, Fulk expressed his doubts that the **HEPA** filters on the proposed incinerator would stop plutonium particles from escaping into the **...**
Page 302
... 43-44 high-efficiency particulate air (**HEPA**) filters: nuclear waste disposal and, 210215-16 Hiroshima bombing:

OTHER ITEMS ON HEPA FILTERS:

1. **Depleted Uranium DENNIS KUCINICH / 2004 Campaign Platform 15mar04**

   Gulf War soldiers in Mission-Oriented Protective Posture (MOPP) suits, which have *HEPA* filters. **They do not in any way protect them from ultrafine DU dust. ...**
   www.mindfully.org/Nucs/2004/Depleted-Uranium-Kucinich15mar04.htm - 12k - Cached - Similar pages

2. **The War May Entail Ecological Disaster in the World YELENA ...**

   will penetrate even a *HEPA* filter (High Efficiency Particulate Airfilter **...** personnel are much less efficient than *HEPA* filters. There are 1 **...**
   www.mindfully.org/Heritage/2003/Iraq-Ecological-Disaster22mar03.htm - 11k - Cached - Similar pages

3. **A SURVEY OF MIXED-WASTE HEPA FILTERS IN THE DOE COMPLEX (separately submitted PDF as ANNEXURE K)**

   F. S. Felicione, D. B. Barber, and K. P. Carney
   Argonne National Laboratory-West
   P. O. Box 2528
   Idaho Falls, ID 83403
   ABSTRACT
   A brief investigation was made to determine the quantities of spent, mixed-waste HEPA filters within the DOE Complex. The quantities of both the mixed-waste filters that are currently being generated, as well as the legacy mixed-waste filters being stored and awaiting disposition were evaluated. Seven DOE sites representing over 89% of the recent HEPA filter usage were identified. These sites were then contacted to determine the number of these filters that were likely destined to become mixed waste and to survey the legacy-filter quantities. Inquiries into the disposition plans for the filters were also made. It was determined that the seven sites surveyed possess approximately 500 m3 of legacy mixed-waste HEPA filters that will require processing, with an annual generation rate of approximately 25 m3. No attempt was made to extrapolate the results of this survey to the entire DOE Complex. These results were simply considered to be the lower bound of the totality of mixed-waste HEPA filters throughout the Complex. The quantities determined encourage the development of new treatment technologies for these filters, and provide initial data on which an appropriate capacity for a treatment process may be based.
   WM=02 Conference, February 24-28, 2002, Tucson, AZ

TO DATE THERE HAS BEEN NO RESPONSE FROM THE NATIONAL NUCLEAR REGULATOR (NNR) TO OUR REQUEST FOR INFORMATION ON HEPA FILTERS

From: Pelindaba Working Group [mailto:pelindabanonukes@gmail.com]
Sent: 06 March 2009 12:56 PM
To: 'Thiagan Pather'; 'Orion Phillips'

Cc: 'Gino Moonsamy'
Subject: RE: HEPA filters & Pelindaba incinerators/smelters

Dear Thiagan and Orion

Please find my enquiry to the NNR in the email to Gino below. I would sincerely appreciate response from you.

Regards
Dominique Gilbert

From: Gino Moonsamy [mailto:gmoonsamy@nnr.co.za]
Sent: 06 March 2009 11:39 AM
To: Pelindaba Working Group
Cc: Thiagan Pather; Orion Phillips; Orion Phillips
Subject: RE: HEPA filters & Pelindaba incinerators/smelters

Dear Dominique

My Colleagues Thiagan and Orion are better positioned to advise on your enquiry.
kind regards
Gino Moonsamy

From: Pelindaba Working Group [mailto:pelindabanonukes@gmail.com]
Sent: Thu 2009/03/05 11:57 PM
To: Gino Moonsamy
Subject: HEPA filters & Pelindaba incinerators/smelters

Dear Mr. Moonsamy

I understand you are now the Manager: Communications and Stakeholder Relations at the National Nuclear Regulator and hope you can kindly assist me, if not directly, then via someone at the NNR who is able to answer my question.

I have registered as an I&AP on the amendment of the ROD for the Fuel Plant at Pelindaba. We are somewhat concerned about the proposed incinerator that will now be part of the plant and in particular seek information about the HEPA filters which are intended to be used.

Are there any NNR regulations or license requirements that deal specifically with the use of HEPA filters in nuclear applications, and specifically also in terms of radioactive waste incinerators?

Any information you may provide in this regard will be gratefully appreciated as it will enable us to more accurately provide comment on the issue to the Minister. As the deadline for this comment is imminent, I appeal to you for a quick response.

Thank you in advance. I do hope to hear from you.

Kind regards
Dominique Gilbert
Coordinator
PELINDABA WORKING GROUP
Tel: 012 - 205 1125
Cell: 083 740 4676

TO DATE THERE HAS BEEN NO RESPONSE FROM THE NUCLEAR ENERGY CORPORATION OF SOUTH AFRICA (NECSA) TO OUR REQUEST FOR INFORMATION ON HEPA FILTERS

From: Pelindaba Working Group [mailto:pelindabanonukes@gmail.com]
Sent: 05 March 2009 11:57 PM
To: Chantal Janneker
Subject: HEPA filters & PSIF

Dear Chantal

I write in the hope you can assist me on the queries below:

1. We have registered to comment on the amendment to the Fuel Plant ROD and are concerned about the inclusion of an incinerator in the new design. Some of the PBMR engineers at the open day explained how they work but we remain concerned about the reliability of HEPA filters – an issue which cropped up with the proposed waste Smelters. Can you tell me how many HEPA filters are currently in use at the Pelindaba Complex and in which facilities? And is it possible to provide us with information about how safe they are and what regulatory control has been prescribed in terms of use of HEPA filters in nuclear applications?

2. I understand there was a PSIF meeting in February at which a new chairman was elected. My name seems to have been repeatedly scratched off the lists as I never get notification of these meetings and only managed to attend the last one after I stumbled on a notice inside a local petrol station. How can I ensure that I'm notified of these meetings and is it possible to get back copies of the minutes of these meetings, including February's meeting?

3. Is there any development in terms of the Smelter Plants? We are eager to know what is being planned in this regard.

Your cooperation will be appreciated.
Sincerely
Dominique Gilbert

Coordinator
PELINDABA WORKING GROUP
Tel: 012 - 205 1125
Cell: 083 740 4676