The flow pattern

To find the form factor the air flow in the stack was mapped by means of a tracer gas. It was equally important to find a suitable injection point for the subsequent tests with particles. Suitable means in this context that at most a small fraction of the test aerosol is lost on the way from the injection point to the sampler section in the stack, but at the same time it is reasonably well distributed over the sampling section.

Ethanol was chosen as the tracer gas, for which simple solid state sensors are available, sensitive down to the ppm level (Scimarec AF 63, Japan). These sensors are no precision devices, but they are small, rugged, easy to apply, and cheap. 9 sensors were mounted on a cross-shaped frame, connected to a data logger, and hoisted to the sampler level. Ethanol was then injected by means of a compressed air atomizer in a number of points in the stack base chamber. Each injection consumed 1 litre of ethanol and took 10 minutes. Figure 2 shows some of the concentration patterns observed at the sampler level. The three ventilation air streams are evidently not well mixed when they reach the sampler. The arithmetic mean of the observed concentrations was calculated, to be used as a substitue for C_{mean}, and by interpolation also the concentrations at the four sampler inlets, and C_{in} (C_{mean} should not be taken from the injection rate, because of drift in sensor calibration). From this the form factor for the different injection points is obtained. These are provided in the key to Figure 2. In spite of the uneven distributions, the form factor is confined to the range 0.74 - 1.24.

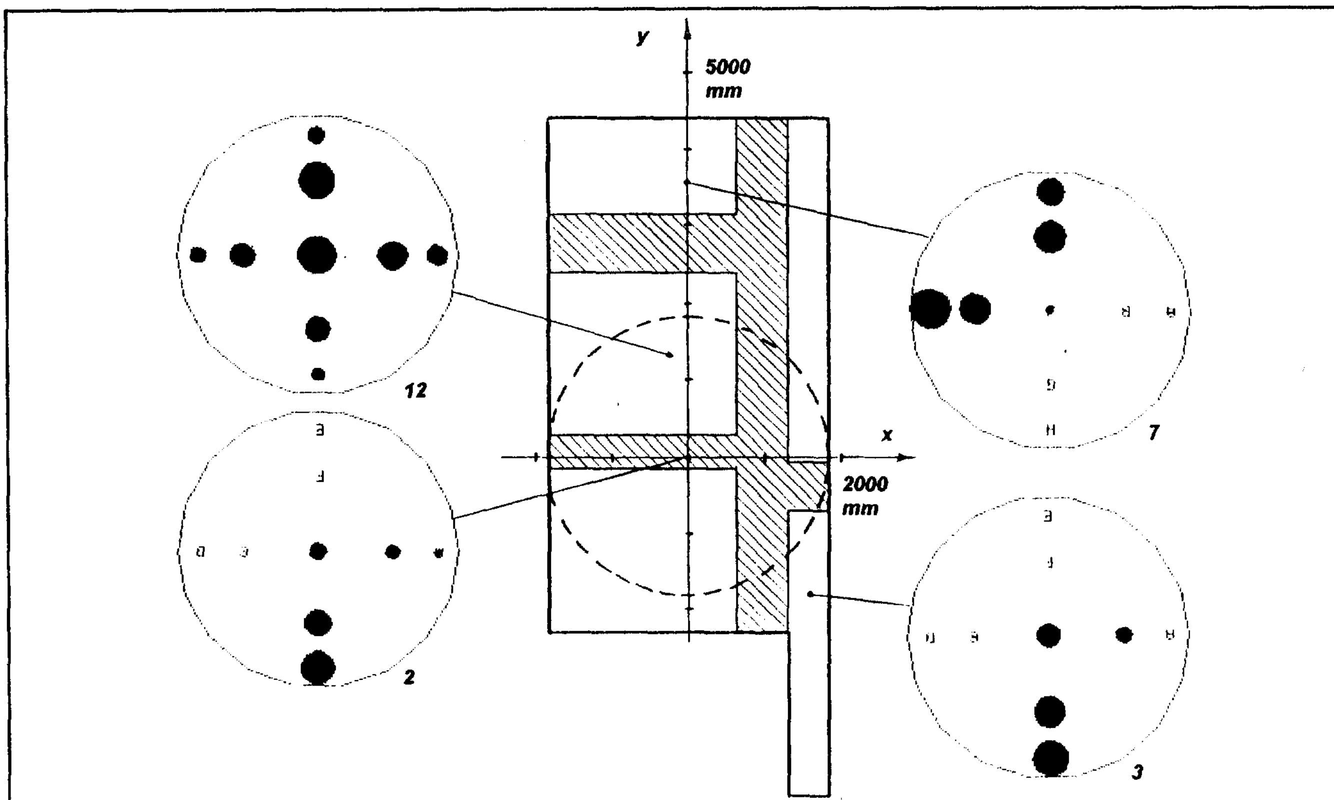

Figure 2. Observed tracer gas concentrations in the 9 measurement points at the sampler level, and the calculated form factors f for the sampler istallation. The dot areas are proportional to concentration.

		x, mm	y,mm	f
Injection 2:	*On the centerline of the stack*	*0*	*0*	*0.74*
Inlection 3:	*In ventilation channel Auxiliary Building*	*1575*	*-1800*	*0.82*
Injection 7:	*In ventilation channel Reactor Building*	*0*	*3500*	*1.00*
Injection 12:	*In ventilation channel Turbine Building*	*-250*	*1300*	*1.24*

The particle tests

Monodisperse styrene - divinylbenzene particles were obtained from DYNO Particles, Norway. The particles were sulfonated and tagged with dysprosium, as a preparation for activation analysis. Three different sizes were employed, with the following properties:

Particle properties

Manufacturer's designation	Q-673	Q-501	Q-851
As received:			
Diameter, µm	4.6	8.6	15.3
Standard deviation, %	1.1	0.9	1.8
After sulfonation:			
Diameter, µm	4.9	9.1	16.3
Density, kg/m^3	1595	1316	1300
Dysprosium, g/kg of particles	109	39.5	35.6
Aerodynamic diameter, µm	6.2	10.4	18.6

The dysprosium was very strongly connected to the particles, with less than 1 % in the liquid phase of the particle suspension.

The particles were to be dispersed from a methanol suspension, and it was feared that the particles would acquire an electrical charge in the process. The charge of the smallest particles after dispersion in a test chamber was therefore measured. With pure methanol (conductivity 0.15×10^{-3} 1/Ωm) a mean charge of about 300 electrons was observed. By adding a small amount of potassium chloride solution to the suspension the conductivity was increased about 10 times, which decreased the particle charge by a similar factor. Such a low charge is not expected to influence particle deposition.

From the droplet spectrum of the atomizer it was calculated that if the particle concentration in the dispersion was 10^{14} particles/m^3 then only about 1 % of the particles generated would be duplets or higher combinations. This was confirmed by measurements. The atomizer was a Lechler 156.330.30.16, the dispersion gas carbon dioxide, the gas pressure 300 kPa, and the methanol flow 8 g/s.

One of the objectives of these tests was to demonstrate that it is possible to conduct the test aerosol to the sampler level without significant losses. With the tracer gas tests it had been observed that injection at the coordinates x=-250 mm, y=1300 mm (Figure 2) gave a symmetrical pattern at the sampler level, with lower concentration at the walls. These conditions would favour low particle losses to the stack walls, and the above coordinates were used for the particle injections.

Particles were dispersed in the stack base chamber, and the particle flow at the sampler level measured by means of eight filter samplers. The form factor for these extra samplers and the chosen injection point was estimated at 0.92. An "injection efficiency" can be calculated as

$$H = \frac{\textit{Concentration at sampler level}}{\textit{Injected concentration}} = \frac{C_{A..H}\,/\,0.92}{M_{inj}\,/\,t\,Q}$$

where

$C_{A..H}$	Mean concentration measured by the eight samplers
M_{inj}	Injected amount
Q	Stack flow
t	Injection time in seconds

The following results were obtained. The (rather uncertain) results from a calculation of the losses by means of turbulent deposition theory are also provided in the table.

Injection efficiency

Injection number	1	2	3	4	5	6
Particle size, µm	6.2	6.2	10.4	10.4	18.6	18.6
Dy injected, mg	27	33	54	53	191	190
Efficiency, measured	1.10	1.13	1.03	1.12	0.85	0.97
Efficiency, calculated	1	1	1	1	0.96	0.96

The measurements indicate that the particles are overrepresented in the filter samples. The reason could be an incorrect form factor, or non-isokinetic sampling. The important conclusion of this test is, that the injection losses are no greater than 10%, even for the largest particles. The calculation of deposition indicated that the reduced deposition velocity, k^+, for the largest particles had its maximum value, 0.2. Still larger particles, currently considered in connection with new monitor installations, might not deposit faster in the stack.

Sampling line transmission efficiency

During the six injections mentioned above particles were also collected with the ordinary filter of the sampling installation. The transmission efficiency is calculated as

$$\eta = \frac{C_{out}}{C_{in}} = \frac{1}{f}\frac{C_{out}}{C_{mean}} = \frac{Q}{q}\frac{1}{f}\frac{1}{H}\frac{\textit{Collected amount}}{\textit{Injected amount}}$$

where

f	Form factor C_{in}/C_{mean}
Q	Stack flow
q	Filter flow
H	Injection efficiency

The following results were obtained

Transmission efficiency

Injection number	1	2	3	4	5	6
Particle size, µm	6.2	6.2	10.4	10.4	18.6	18.6
Efficiency η, %						
Loop 2	13*	62	7	8	2	4
Loop 3	47		8		3	
Loop 4	45		7		6	
DEPOSIT calculation	65	65	16	16	0.2	0.2

*probably a gross error

In the table above is also cited the particle transmission calculated with the computer program DEPOSIT 2.0, ref 1. The computer program predicts reasonably well the particle size dependence, considering that the sampling system might be rather dirty, and that the adhesion at contact with the pipe surfaces might be incomplete for the largest particles.

Conclusions

It was demonstrated that in a simple but real geometry a test aerosol could be brought to the sampling section of the monitor installation with only small losses. The mean concentration can then be calculated from the injected quantity of particles, and separate sampling in the stack is not necessary. This simplifies testing considerably. Instead flow mapping with a tracer gas must be performed, to determine a suitable injection point for the test aerosol, and to find the form factor. But it is much easier to measure a gas than to measure particles.

Reference

1. Fan, B J et al. Aerosol particle losses in sampling systems. Paper 6-3, 22nd DOE/NRC Nuclear Air Cleaning and Treatment Conference. Denver, Colorado, USA, August 1992.

DISCUSSION

BARLOW: My question is, if you had field conditions where the number of very large particles was very small, would you get any statistical effects which would render that 2-3% penetration (that you observed in your experiments using similar amounts in each particle size) very variable so that on some days you might get, say, 50% through?

STRÖM: One or two large particles may well be responsible for the bulk of the radioactivity in the sample under real conditions. The statistical nature of the sampling process in the stack will produce variations in the sample. Penetration through the sampling line is strongly size dependent, and statistical variation will only be added in the narrow transition range.

DUVALL: In your last slide you showed poor transmission for large particle sizes, i.e., those over 10 μm. I think it is a very important point because it illustrates the limitation of extractive sampling and a need to assure that large particles are not slipping through cracks in HEPA filters that develop between the filter medium and frame and so go undetected by extractive sampling. These large particles carry a large contribution of the radioactivity in the stack effluent to atmosphere. This illustrates a linkage of requirements for emission monitoring with requirements for air cleaning.

STRÖM: Particles from damaged filters are especially difficult to monitor, because such particles can be parts of the dust cake or the filter, and consequently very large. Sampling for filter damage requires special techniques.

THE INFLUENCE OF SALT AEROSOL ON ALPHA RADIATION DETECTION BY WIPP CONTINUOUS AIR MONITORS

William T. Bartlett and Ben A. Walker
Environmental Evaluation Group
7007 Wyoming Boulevard, N.E., Suite F-2
Albuquerque, New Mexico 87109

Abstract

Waste Isolation Pilot Plant (WIPP) alpha continuous air monitor (CAM) performance was evaluated to determine if CAMs could detect accidental releases of transuranic radioactivity from the underground repository. Anomalous alpha spectra and poor background subtraction were observed and attributed to salt deposits on the CAM sampling filters. Microscopic examination of salt laden sampling filters revealed that aerosol particles were forming dendritic structures on the surface of the sampling filters. Alpha CAM detection efficiency decreased exponentially as salt deposits increased on the sampling filters, suggesting that sampling-filter salt was performing like a fibrous filter rather than a membrane filter. Aerosol particles appeared to penetrate the sampling-filter salt deposits and alpha particle energy was reduced. These findings indicate that alpha CAMs may not be able to detect acute releases of radioactivity, and consequently CAMs are not used as part of the WIPP dynamic confinement system.

I. Introduction

This paper discusses how aerosol particle collection on alpha continuous air monitor (CAM) sampling filters influences the reliability of CAM measurements. As a consequence of this study, the design of the Waste Isolation Pilot Plant (WIPP) radioactive confinement system was reevaluated, and a number of additional facility safeguards were added to reduce risks to workers and the environment.

Alpha CAMs were installed to monitor for transuranic radionuclides in the WIPP mine exhaust air. Mine exhaust air is normally unfiltered and flows at a rate as high as 425,000 cubic feet per minute (CFM). If radioactive aerosol were detected, then air flow would be diverted to high efficiency particulate (HEPA) filters and lowered to 60,000 CFM. At the lower air flow rate, some underground operations are not allowed; at high air flow, full underground operations are allowed. Thus, effluent CAMs are important in monitoring unfiltered air flow.

The 1990 WIPP Safety Analysis Report (SAR) required CAMs to be operational whenever unfiltered air was vented.[1] If an effluent CAM was non-operational for an hour, then operations were to be curtailed. Because of the importance of effluent CAMs, the Environmental Evaluation Group (EEG) recommended laboratory and in-situ testing to establish the reliability and detection efficiency of alpha CAMs.[2]

The WIPP repository is located in a bedded-salt formation 655 m (2150 ft) below the surface. The exhaust air contains high-salt-aerosol concentrations during mining, backfilling and other underground operations. It was assumed that alpha particle detection efficiency would not be significantly affected by the salt aerosol. Aerosol particles were expected to impact on the surface of the CAM sampling filters, or on the surface of sampling-filter salt deposits. Because radioactivity would be on the surface of the filter or salt deposit, alpha particle energy would not be reduced before interacting with the CAM detector. For chronic radioactive releases, it was suggested that a saturation plutonium count rate would occur when sampling-filter-salt-deposit thickness exceeded the range of the alpha particles.(3)

The EEG reviewed CAM operational data and found that alpha spectra and radon-thoron daughter background subtraction were significantly affected by the magnitude of sampling-filter salt deposits.(2) These problems were persistent, once a salt deposit accumulated on the sampling filter. The Waste Isolation Division (WID) of the Westinghouse Electric Corporation, located at the WIPP site, addressed this problem by modifying the alpha CAM detector-filter chamber design, but spectral anomalies and poor background subtraction were still observed.(4) It became apparent that aerosol was not collecting on the surface of sampling-filter salt deposits.

In the following discussion, the alpha CAM design is reviewed, particle collection mechanisms discussed, and operational data are presented. From this information, it was concluded that CAMs could not perform their intended function, as required in 1990 SAR. Changes in the facility operations and safeguards were instituted.

II. WIPP Alpha CAM Design, Location and Particle Collection Efficiency

The WIPP alpha CAMs are modified Eberline Model Alpha-6 CAMs and are designed to account for the limited range of alpha particles. Sampled air passes through a membrane filter of either 25 mm (1 in) or 47 mm (1.8 in) in diameter, and when present, salt dust collects on the surface of the sampling filter. The sampling filter is juxtaposed approximately 5 mm (0.2 in) from a 25-mm (1 in) diameter alpha detector (Figure 1). The Figure 1 filter-detector geometry allows alpha particle detection efficiency as high as 11% of the particles emitted (4π efficiency).

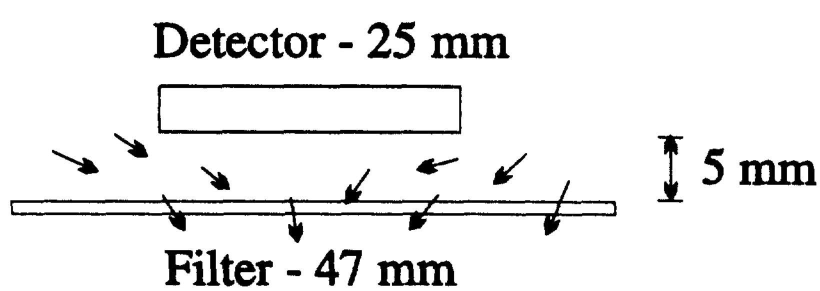

Figure 1 Detector-filter geometry (arrows indicate air-flow path).

The Alpha-6 monitor has a 256-channel spectrometer capable of discriminating ^{239}Pu and ^{238}Pu (5.1 and 5.5 MeV) alpha particles from naturally occurring alpha radiation, particularly alpha peaks from ^{218}Po and ^{212}Bi (6.0 to 6.09 MeV), ^{214}Po (7.69 MeV) and ^{212}Po (8.78 MeV). Net plutonium channel counts are derived by using a fixed region-of-interest (ROI) subtraction method(5) as shown below:

$$\mathbf{Pu_{net} = (ROI\text{-}1) - [k * \{(ROI\text{-}2) * (ROI\text{-}3)\} / (ROI\text{-}4 + 1)]} \quad (1)$$

where

Pu_{net} = Net counts in plutonium region
ROI-1 = Counts in region 1, plutonium (channels 92-126)
k = k-factor, constant
ROI-2 = Counts in region 2, ^{218}Po, ^{212}Bi (channels 136-143)
ROI-3 = Counts in region 3, ^{214}Po (channels 148-178)
ROI-4 = Counts in region 4, ^{212}Po (channels 179-186)

Figure 2 shows a typical alpha background spectrum, and designated ROIs. If the subtraction method is working properly, the average Pu_{net} count rate will be zero. If the alpha spectrum is anomalous or degraded, ROI-4 may be disproportionately low and cause Pu_{net} to be negative.

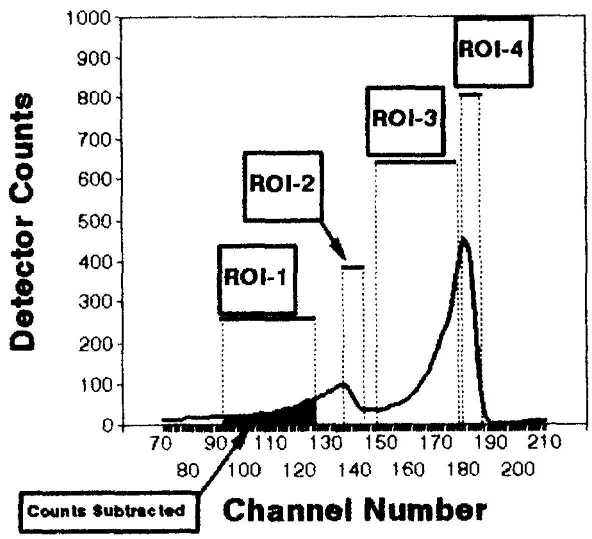

Figure 2 ROIs for alpha background subtraction.

There are four WIPP test CAMs discussed in this report. Three CAMs (153, 157 and an in-line prototype) are located in an above-ground sampling station (Station A) directly above the air exhaust shaft (see Figure 3). All mine air vents through the air exhaust shaft, and consequently, any salt aerosol produced underground can potentially affect the Station-A CAMs. A forth CAM (129) is at the north end of room 1, panel 1 of the underground repository (Figure 3). The repository horizon is approximately 655 m (2150 ft) below the surface. There is usually little salt aerosol in room 1, panel 1 and the performance of CAM 129 in a low aerosol location was compared to the CAMs at Station A where salt aerosol is most likely.

Station-A CAMs are off-line monitors. Sample lines equipped with specially-designed shrouded probes extend from the Station-A sampling room into the exhaust shaft and can continuously sample the underground air effluent at a free stream velocity range of 2 to 14 m s^{-1} (6.5 to 46 ft s^{-1}) and at a rate of 170 L min^{-1} (6 CFM).[6] The sampled air is pulled into three separate collection ports at 56 L min^{-1} (2 CFM). The transmission ratio of particle sizes up to 10 μm AD (aerodynamic diameter) through the shrouded probe is expected to be 0.93 to 1.11.[6]

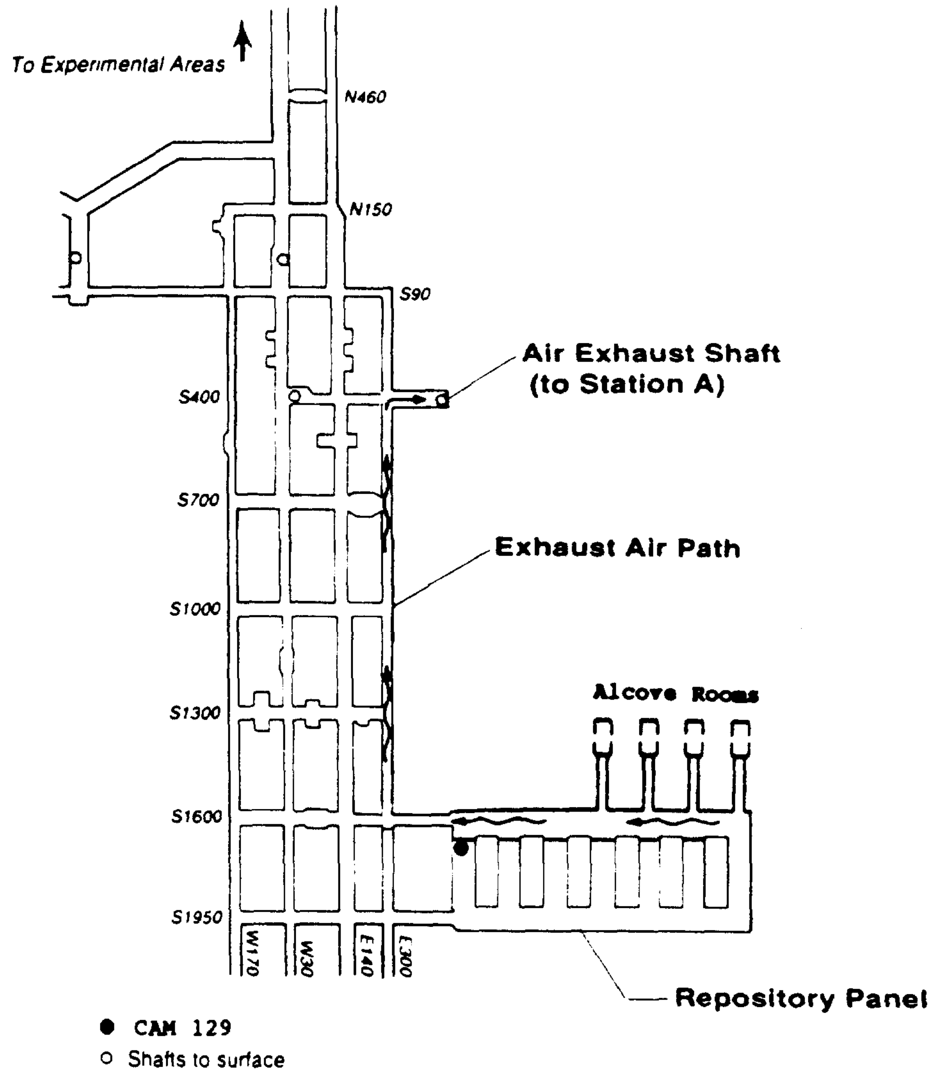

Figure 3 Main areas of underground repository (CAM 129 is located in room 1, panel 1, and station-A CAMs are located at ground level above the air exhaust shaft.)

CAM 129 is equipped with a radial annulus sample head in which aerosol enters the head from any direction around the rim at 28 L min^{-1} (1 CFM). The radial annulus sampler allows essentially 100% collection of particle sizes up to 6 to 8 μm AED (aerodynamic equivalent diameter) at 28.3 L min^{-1} to 85.0 L min^{-1} (1 to 3 CFM) and wind speed of 1 m s^{-1} (3.28 ft s^{-1}).[7]

In diesel-equipped mining operations similar to the WIPP, a bimodal distribution of airborne particles of 0.2 μm and 5 μm average aerodynamic diameter is typical.[8] WIPP measurements indicated a similar distribution and that the aerosol is primarily NaCl.[9]

The ratio of radon-thoron progeny attached to WIPP salt-diesel aerosol is unknown. The NCRP[10] states that mine aerosol concentrations would have to be extremely low to allow unattached fractions to exist. Other investigators suggest that the unattached fraction in diesel-equipped mines is much less than 1%.[11] The WIPP is primarily a day-shift operation, and aerosol concentration may vary widely over a 24-hr period. Alpha spectra shown in this report are primarily from day-shift operations when aerosol concentrations are expected to be high.

III. Potential for Degraded Alpha Spectra

CAM sampling-filter mass loading is as high as 2 to 3 mg cm^{-2} for underground operations, but can be in the range of 15 to 20 mg cm^{-2} during backfilling or some mining operations.[2] Twenty-four hour average air concentrations are as high as 0.3 to 0.5 mg m^{-3}, and up to 2.5 to 3.3 mg m^{-3} in extreme conditions.

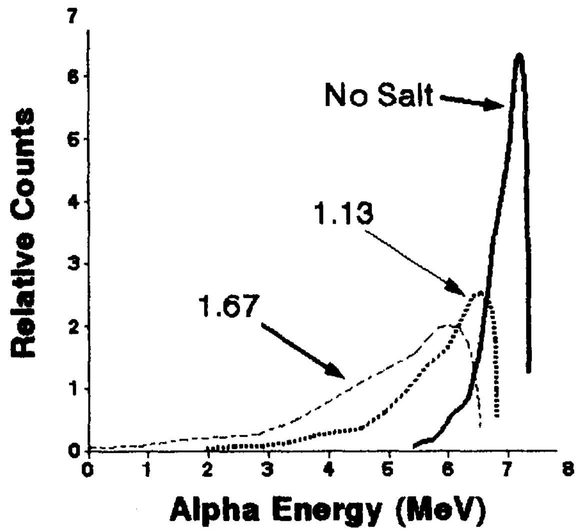

Figure 4 Theoretical reduction a ^{214}Po alpha spectrum with 1.13 and 1.67 mg cm^{-2} salt interposed between the source and detector.

Alpha measurements are dependent on the CAM filter-detector geometry (Figure 1). Radioactivity on the sampling-filter surface will emit alpha particles isotropically. Using the filter surface as the source, alpha particle direction, path length and kinetic energy were predicted and calculated, considering the influence of air and varying salt thicknesses.[4] Figure 4 shows a calculated ^{214}Po (7.69 MeV) alpha spectrum and the effect of interposing as little as 1 mg cm^{-2} of

Table 1 Theoretical ^{238}Pu and ^{239}Pu Alpha Efficiencies*.

Depth in Salt mg cm^{-2}	Efficiency, % (4π)			
	^{239}Pu (5.1 MeV)		^{238}Pu (5.5 MeV)	
	ROI 92-126	ROI 65-126	ROI 92-126	ROI 65-126
0	10	12	11	12
0.56	6	10	5	11
1.13	1	6	2	10

*Efficiencies are relative to a 10% no-load 5.1 MeV efficiency.

salt between the source and detector. The spectral effects of interposed salt are more pronounced when less energetic ^{238}Pu (5.5 MeV) and ^{239}Pu (5.1 MeV) alpha particles are the source. The theoretical efficiency of the Alpha-6 was calculated as shown in Table 1.[4] Changing the lower ROI-1 discriminator setting from 92 to 65 improves theoretical plutonium efficiency, but the overall CAM performance may be affected by other factors such as false alarm rates or background subtraction.

IV. Particle Collection Mechanisms

The EEG collects fixed-air sampling filters each day at the above ground sampling site, Station A. Salt particles ranging in physical size up to 7 μm in diameter were observed using a scanning electron microscope. Microscopic analyses also revealed numerous dendritic structures on the sampling-filter surface. If exposed to high humidity the dendritic structures tend to collapse and form a confluence.[2] Sputtering the sampling-filter surface, as a preparation for electron microscopic analysis, also disrupted the dendritic structures, as did viewing with a scanning electron microscope for long periods. In general, the sampling-filter salt deposits appeared loosely formed and porous. If observed with a light microscope, the dendritic structures remained stable.

The microscopic observations strongly indicated that the aerosol particles are electrostatically bound. The dry, hygroscopic nature of the WIPP salt repository favors electrostatic buildup, and particle-to-particle interactions were evident in our observations. There are no pressure drop measurements across the sampling filter, but air flow is maintained relatively constant by flow control devices. Data from 1993 indicated only 2 days during the year when air-flow rate decreased by more than 10% during a 24-hour sampling period. The lack of filter clogging suggested that the particle packing fraction was low and that air easily passed through the sampling-filter salt deposit.

Because of these observations, it was hypothesized that the sampling-filter salt deposits may behave more like a fibrous filter than a membrane filter. If so, aerosol would penetrate differentially into the salt deposit. As the salt layer becomes thicker, more particles penetrate deeper into the salt deposit. The deeper the aerosol penetrates into the sampling-filter salt deposit, the greater the potential exists for reduced alpha particle energy and poor alpha spectra.

It was suggested that a monodisperse particulate aerosol will collect differentially on a fibrous filter with the fewest particles penetrating to the greatest depth in the filter,[12] and particle penetration was described by a simple differential equation with the following solution:

$$\mathbf{N(x) = N(o)\ e^{-\alpha x}} \qquad (2)$$

where
$N(x)$ = particle concentration at depth x
$N(o)$ = particle concentration at surface, $x = 0$
α = layer efficiency ($cm^2\ mg^{-1}$)
x = layer thickness ($mg\ cm^{-2}$)

and

$$\mathbf{P = N(x) / N(o) = e^{-\alpha x}} \qquad (3)$$

where P = penetration fraction

A plot of a hypothetical, monodisperse aerosol penetrating a fibrous matrix appears in Figure 5. A polydisperse aerosol was described as having a more complex penetration pattern and for a bimodal distribution was characterized as follows:[12]

$$P = (1-\beta)\, e^{-\alpha 1\, x} + \beta\, e^{-\alpha 2\, x} \qquad (4)$$

where

P = penetration fraction
$\alpha 1$ = layer efficiency of first aerosol fraction ($cm^2\ mg^{-1}$)
$\alpha 2$ = layer efficiency of second aerosol fraction ($cm^2\ mg^{-1}$)
ß = fraction of the $\alpha 2$ aerosol particles
x = layer thickness ($mg\ cm^{-2}$)

A plot of a typical monodisperse aerosol penetrating a matrix is represented by either line 1 or 2 in Figure 6. Line 1 shows a highly penetrating fraction while line 2 shows a less penetrating fraction. Line 3 is a combination of two monodisperse aerosol fractions and is characteristic of a bimodal or polydisperse aerosol.

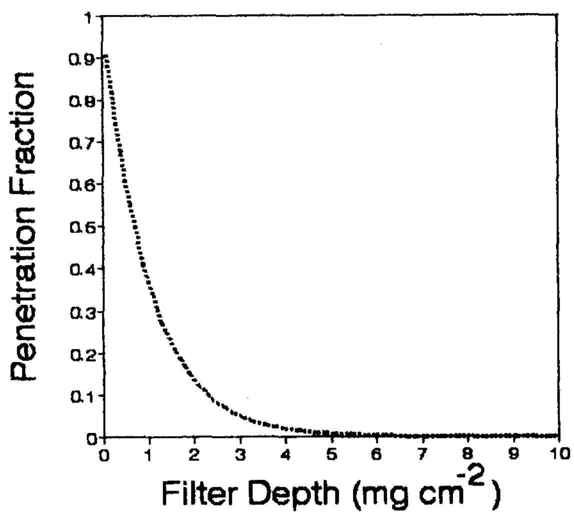

Figure 5 Monodisperse penetration of aerosol into a filter.

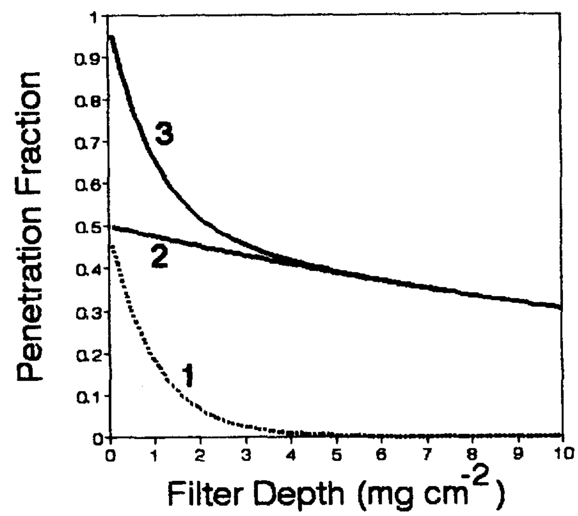

Figure 6 Polydisperse penetration of aerosol into a filter.

IV. Operational Data

Early in 1991, the maximum ^{214}Po peak height at the end of a 12-hour sampling period was evaluated as a function of sampling-filter salt loading, and a declining relationship was found (Figure 7). Following extensive CAM modifications in 1991 and 1992, a similar analysis was performed for a 24-hour sampling period, and a declining relationship was again found (Figure 8). These simple analyses indicated that sampling-filter salt loading was affecting alpha spectra and suggested the need for additional analyses.

CAM sampling filters are changed each morning before underground activities begin, and with a clean filter in place, well resolved spectra begin accumulating. Spectra typically become degraded mid-morning when underground operations begin. The poor spectra persist until filters are changed.

An example of the effects of sampling-filter salt loading occurred on January 25, 1994 when backfill demonstrations were conducted in the alcove rooms (Figure 3). Hourly spectra from 9:00 a.m. to 1:00 p.m. are shown for the underground CAM 129 and Station A CAMs (153, 157, and in-line) in Figure 9. The Station A CAMs accumulated 11 mg cm^{-2} during this sampling period, whereas CAM 129 was out of the salt aerosol air flow and accumulated very little salt deposit. The Station A CAM spectra became severely degraded after 9:00 a.m and continued to be degraded until the sampling filters were changed the next day. CAM 129 spectra remained well resolved.

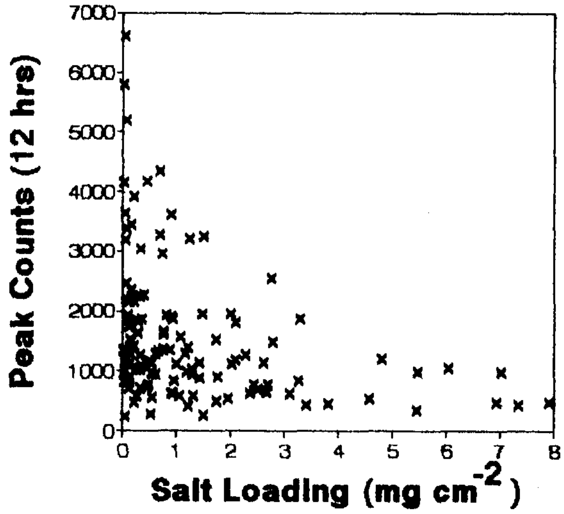

Figure 7 Maximum peak height of ^{214}Po, CAM 153, 1991, 12-hr sampling period.

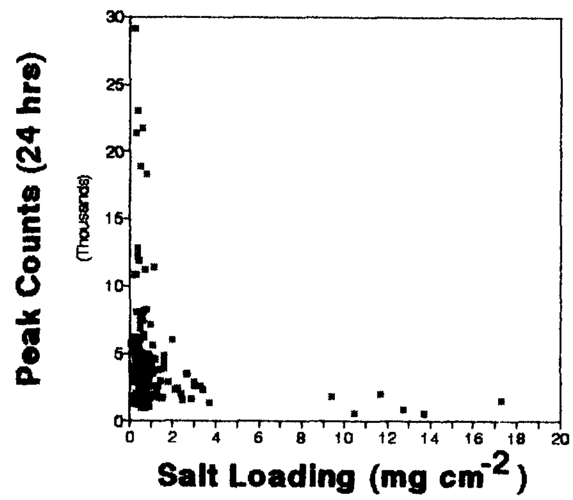

Figure 8 Maximum peak height of ^{214}Po, CAM 157, 1992-3, 24-hr sampling period.

In addition to maximum peak height, the full-width-at-half-maximum (FWHM) of ^{214}Po alpha peaks was used as a performance indicator for alpha spectra. ^{214}Po peak resolutions were calculated for days in January through March 1994 when salt loading varied from near zero to as high as 17 mg cm^{-2}. The average FWHM during a 5-hour afternoon period was calculated and graphed as shown in Figure 10. The FWHM is normally in the range of 14 to 20 channels. The data indicate that as little as 1 to 2 mg cm^{-2} salt loading causes the FWHM to be greater than 20. The increase in FWHM and loss in ^{214}Po resolution at relatively low sampling-filter salt loading (1 to 2 mg cm^{-2}) is consistent with theoretical calculations in Figure 4.

The net counts in the plutonium ROI (Pu_{net} from Equation 1), were also plotted in Figure 10 as a function of filter salt loading. The data indicated periods of very negative Pu_{net} counts (< -100 CPM) for 3 to 5-hour periods. Compared to an effluent alarm setting of 40 CPM, these negative excursions are significant. At relatively low salt loading (0 to 2 mg cm^{-2}), the background subtraction appears reasonably good. At salt loading above 2 mg cm^{-2}, there was consistent oversubtraction of plutonium region counts. At very high salt loading (18 mg cm^{-2}), the oversubtraction was not as pronounced, but alpha peaks were essentially non-existent. Pu_{net} was not a consistent CAM performance indicator, but at times, the oversubtraction of plutonium background counts was so extreme that the monitor could not be considered operational.

The total spectrum counts in each of the Station-A CAMs were compared to total counts from CAM 129 during the same time period. The results were graphed as a ratio shown in Figure 11. When salt loading was low, all CAMs had similar total counts. As salt load increased, efficiency dropped quickly. These data are indicative of the quantitative reduction of CAM efficiency as salt

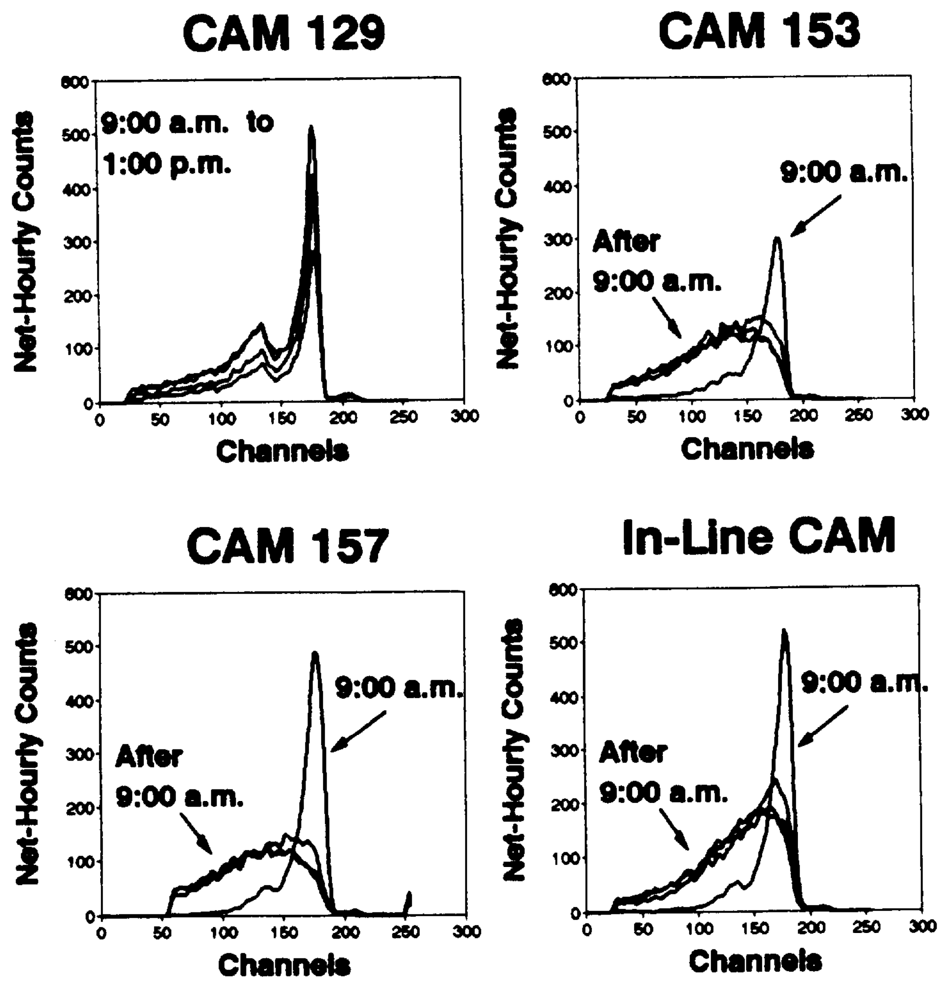

Figure 9 CAM alpha spectra on January 25, 1994.

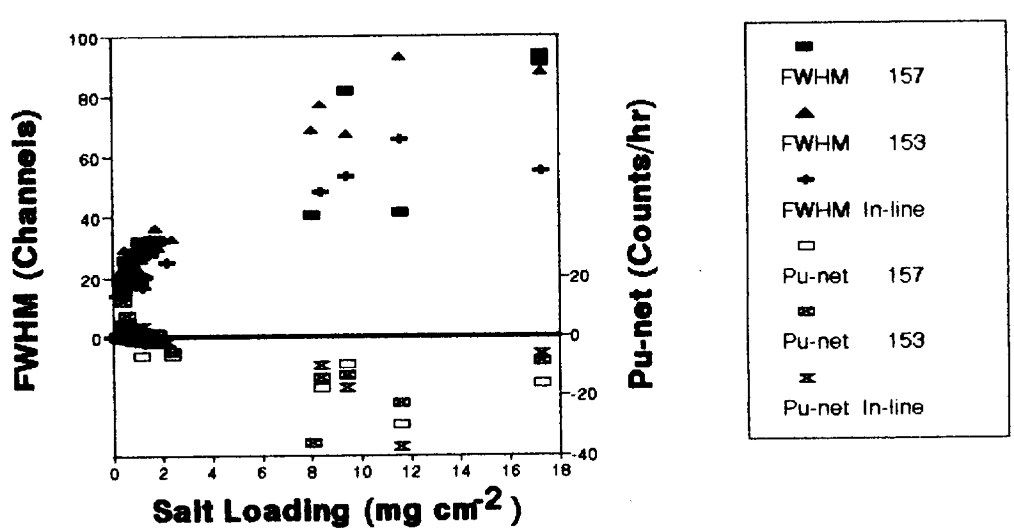

Figure 10 FWHM and Pu_{net} as sampling-filter salt deposits increase.

deposits become greater. The most straightforward explanation is that aerosol particles are penetrating the sampling-filter salt deposit, and alpha particle energy is reduced by interaction with the salt deposits.

If aerosol penetrates a fibrous filter and the sampling-filter salt deposit in a similar manner, then it would be expected that alpha detection efficiency would decrease exponentially as salt deposits increase. The observed relative efficiency data was fit to the exponential equation, e^{-bx} (Figure 12). At the 95% confidence level, data up to 17 mg cm^{-2} yielded a goodness of fit of 0.97. Because previous empirical data[9] and information[8] suggest that the WIPP mine aerosol is a bimodal distribution, data below and above 2 mg cm^{-2} were fit independently with the same exponential equation. The data below 2 mg cm^{-2} yielded a goodness of fit of 0.89, the data above 2 mg cm^{-2} were fit at 0.99. Each of the analyses indicates an exponential loss of counts on CAMs with salt-laden filters. The data suggest that a bimodal distribution is probable, but additional work is needed to confirm this hypothesis.

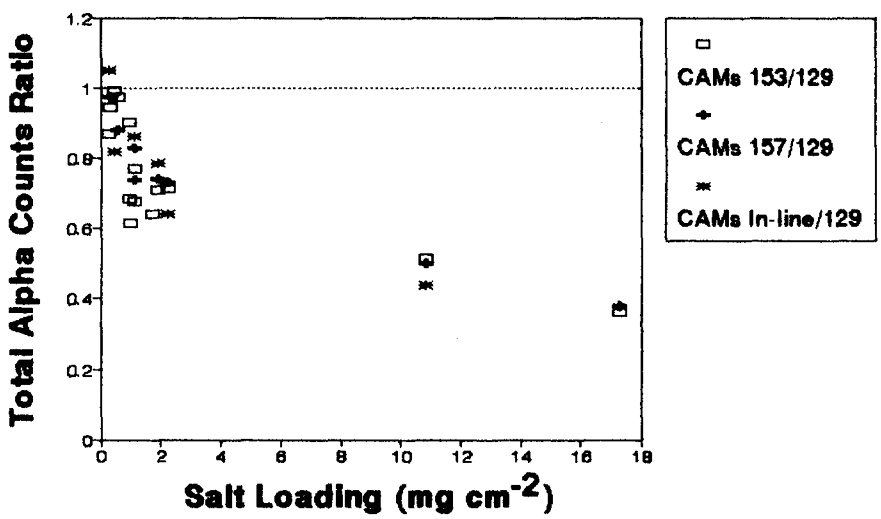

Figure 11 Relative efficiency of station-A CAMs to CAM 129 as a function of salt loading at Station A.

V. Discussion and Conclusions

The operational data and fibrous-filter collection theories suggest that degraded alpha spectra and poor background subtraction are attributed to penetration of aerosol particles into preestablished sampling-filter salt deposits. A number of variables were correlated with sampling-filter salt loading, and each case, there were direct correlations with salt loading. Electron micrographs revealed porous salt deposits and dendritic structures on the surface of the sampling filters. It appeared that once a significant level of salt deposit built up on the surface of a membrane filter, then the filter performed like a fibrous filter, rather than a membrane filter.

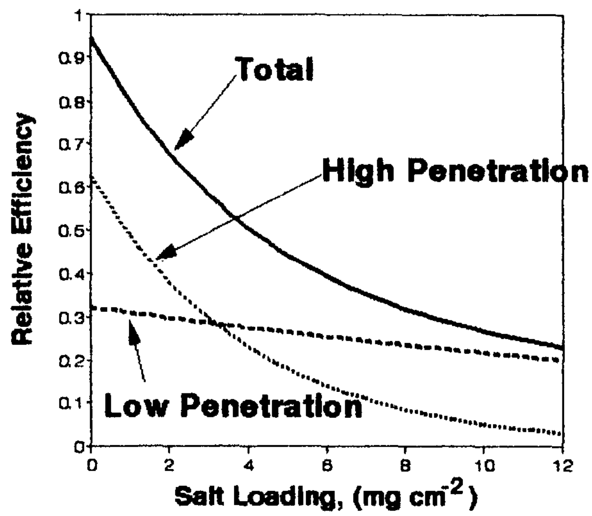

Figure 12 Best fit analysis of relative efficiency data.

If sampled aerosol collected strictly as layers on the surface of the sampling filter, then acutely released radioactive aerosol could be measured, regardless of the sampling-filter salt mass. Neither the reviewed data nor the fibrous-filter collection theories support such a limited mechanism for particle collection. In fact, more questions are raised about the complexity of the aerosol collection mechanism than are resolved. For example, it is generally thought that radon-thoron progeny are attached to ambient salt aerosol, but there are no empirical data to substantiate this assumption. It is not known whether radioactive progeny will preferentially attach to small or large dust particles. If radioactivity were found to attach only to the small particle fraction, then the collection mechanism of small particles would need to be studied. Although it is suspected that aerosol particles are predominantly collected by an electrostatic mechamism, other mechanisms can not be ruled out. And most importantly, it is not known whether transuranic aerosols would behave similarly to those of radon-thoron progeny.

The amount of salt on a sampling filter appears to be a much more important variable than the average-salt-aerosol concentration. Because of this finding, the mass of sampling-filter deposits should be carefully documented, and CAMs ideally should alarm when sampling-filter deposits become significant. Depending on the CAM location and function, the data indicate that sampling filters should be changed when salt deposits are in the range of 0.5 to 2.0 mg-cm^{-2} (Table 1, Figures 11).

Effluent alpha CAMs are no longer a part of the limiting conditions of operations or the dynamic confinement system at the WIPP. Instead, WIPP will reduce potential radioactive uptake risks to workers and the environment by eliminating the operational backfill, restricting radioactive content of waste drums, using underground barriers to control potential releases and fires, modifying ventilation, relocating critical CAM monitors, and changing sampling filters when significant salt buildup is likely.

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DISCUSSION

BRESSON: I thought I heard you say that when you were making measurements and mining operations were being conducted there was a period of enhanced salt concentration in the air. Is that correct?

BARTLETT: That is correct.

BRESSON: Do you have any data that show how the alpha CAM spectrometer system functions when there isn't that kind of activity going on? I would expect such activity would be typical of operations at WIPP. The question is, how do alpha CAMs function when you are not disturbing the environment and creating the particles?

BARTLETT: That's a good question. Figure 2 shows a typical alpha spectrum that you would see at Station A. When there is no salt, the instrument has good resolution, as shown in Figure 2. Your question is interesting because we have been asked this before. Some people think we can not do alpha spectroscopy in a mining environment, but we have five years' worth of electronic data to the contrary. The monitors work well when there is no salt aerosol.

BRESSON: So it is possible to come up with an operational scheme whereby you can rely on the air monitoring system to do its job except during periods when you are deliberately adding contaminants.

BARTLETT: That is very true. In fact, that has been one of our recommendations. The problem is determining when you are going to have salt aerosol collecting on the filter. Rather than manually determining when spectra are poor, it would be advisable to have the monitor automatically recognize poor spectra. Ventilation air could then be diverted to HEPA filters, or other operational options could be considered.

BRESSON: Does the particle size of the salt seem to be several micrometers in diameter?

BARTLETT: Yes, in electron micrographs the largest sized particle we have seen is about 7μm in diameter. There have been other studies by ITRI Research in Albuquerque, NM, in the mid-80's, and they reported particle sizes in the 3-5μm range.

BRESSON: Would a prefilter on the detector system filter out the larger salt particles but allow passage of PuO_2 particles?

BARTLETT: It is not known whether the Pu particles would be attached to the salt.

ENGLEMANN: What is the size distribution of the salt, and of the anticipated plutonium? The geometry you show suggests that salt may deposit around the periphery of the detector, on the filter, and the smaller plutonium makes it hard to get under the detector. Have you considered or tried a cascade impactor?

BARTLETT: There could be a wide range of Pu particle sizes. As mentioned previously, salt particle sizes range up to about 3-5μm.

ENGLEMANN: And larger for the salt?

BARTLETT: That is for the salt.

ENGLEMANN: Now it occurs to me to ask if you have tried the cascade impactor where you would get the activity in the final stage.

BARTLETT: I think that is a good recommendation. That is one of our recommendations, too.

ENGLEMANN: Another question is concerned with the geometry in which the detector is close to the filter. One would expect the salt and the larger particles to be peripheral to the detector. Are they able to make the turn and head toward the center of the filter? I wonder to what extent you are sure that you have a problem, and whether it can be corrected with the geometry.

BARTLETT: Perhaps I have given the wrong impression. Let me go back a bit. The question of geometry and uniform deposition of particles across the filter has been the subject of other studies. As a result of the studies, the collection chamber was redesigned to preclude this problem. I showed you two CAM spectra from station A. One was an older design. Another one was a new design that gives a much more uniform distribution of the particles across the face of the filter. Am I addressing your question?

ENGLEMANN: Perhaps if the fix isn't to correct uneven distribution across the filter, you can collect your large particles around the outside and let the rest go to the center.

BARTLETT: That is difficult.

ENGLEMANN: At any rate, I assume you have studied it?

BARTLETT: Those are questions that have been considered. We have not studied it *per se*, because others have looked at it. I believe these concerns have been addressed by the WIPP project.

SESSION 4

PANEL SESSION: TESTING AIR AND GAS CLEANING SYSTEMS
A) ACCEPTANCE TESTING: PROPOSED AG-1 CODE TA
B) IN-SERVICE TESTING: PROPOSED NUCLEAR STANDARD N511

Tuesday July 16, 1996

Co-Chairmen: S. Banton
M.E. Pest

Panel Members: P. Burwinkel
C. Graves
V. Kluge
L. Leonard

PANEL DISCUSSION

SECTION TA ACCEPTANCE TESTING, DRAFT REVISION 03/06/96

ASME N511-19XX, STANDARD FOR PERIODIC IN-SERVICE TESTING OF NUCLEAR AIR TREATMENT, HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS, DRAFT REVISION 07/09/96

SECTION TA
ACCEPTANCE TESTING

DRAFT
REVISION 03/06/96

Note: This is a draft document. An approved code section may differ in many respects. This draft version is made available for discussion purposes only.

SECTION TA
DRAFT
FIELD TESTING OF NUCLEAR AIR TREATMENT, HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

Tables

Mandatory Appendices

Non-Mandatory Appendices

ARTICLE TA-1000
INTRODUCTION

TA-1100 SCOPE

This section provides requirements for the field acceptance testing of nuclear safety-related air treatment, heating, ventilating, and air conditioning systems in nuclear facilities.

TA-1110 PURPOSE

The purpose of this section is to provide requirements for field acceptance testing, the results of which are used to verify that nuclear air treatment, heating, ventilating, and air conditioning systems perform their intended function.

TA-1120 APPLICABILITY

This section applies to acceptance testing of nuclear safety-related air treatment, heating, ventilating, and air conditioning systems which are assembled, installed and ready for use. Included are requirements for integrated system performance testing under simulated conditions of operation. It is the Owner's responsibility to meet each of the applicable requirements in this section.

TA-1130 DEFINITIONS AND TERMS

The definitions provided in this section supplement those listed in AA-1000.

Abnormal Incident -- any event or condition which may adversely affect the functionality of the nuclear air treatment, heating, ventilating, and air conditioning system.

Acceptance Test -- a test to verify system or component design function following initial field installation, an abnormal incident, replacement, repair, or modification affecting a test reference value.

Adsorbent -- a solid having the ability to concentrate other substances on its surface.

Adsorber -- a device or vessel containing adsorbent.

Adsorber Bank or Filter Bank -- one or more filters or adsorbers secured in a single mounting frame, or one or more side by side panels containing poured or packed air treatment media, confined within the perimeter of a duct, plenum, or vault cross section, sometimes referred to as a stage.

Aerosol -- a stable suspension of particles, solid or liquid, in air.

Challenge -- to expose a filter, adsorber, or other air treatment device to an aerosol or gas of known characteristics, under specified conditions, for the purpose of testing.

Challenge Gas -- a gas of known characteristics, under specified conditions, used for the purpose of testing. For in-place testing of adsorbers, the challenge gas is to be Refrigerant-11 or an acceptable substitute.

NOTE: For Challenge Gas Substitution Selection Criteria, refer to Non Mandatory Appendix TA-C.

Challenge Aerosol--poly-disperse droplets of dioctyl phthalate, (di(2-ethyl hexyl) phthalate), used as challenge aerosol for testing HEPA filter banks for leaks. The challenge aerosol for in-place leak testing of HEPA filter systems, in accordance with this section, is poly-disperse DOP liquid aerosol having an approximate light scattering droplet size distribution as follows:

99% less than 3.0 micrometer diameter
50% less than 0.7 micrometer diameter
10% less than 0.4 micrometer diameter

NOTE: The poly-disperse aerosol used for in-place leak testing of systems differs from the 0.3 micrometer mono-disperse DOP aerosol used for efficiency testing of individual HEPA filters by manufacturers.

HEPA Filter -- (High Efficiency Particulate Air) a disposable, extended- media, dry type filter enclosed in a rigid casing, that has a minimum efficiency of 99.97% when tested with an essentially mono-disperse 0.3 micrometer test aerosol.

In-Service Test -- A periodic test to verify that a system or component continues to meet its intended design function after being placed into operation.

Pressure, Maximum Operating -- The maximum pressure the system components will be subjected to while performing their function. The allowable pressure during abnormal operating conditions which will not physically damage the system (e.g. sudden closure of dampers or registers), shall be considered maximum operating pressure.

Pressure, Operating -- the pressure that corresponds to the normal design operating mode of the system. This pressure is less than or equal to the maximum operating pressure.

Pressure, Structural Capability -- the pressure to which the designer specifies the component or system can be safely operated without permanent distortion.

Reference Value -- one or more achieved values or test parameters that are measured, observed, or determined when the equipment or system is known to be operating acceptably within its design basis range.

System -- An assembly of components, including associated instruments and controls, required to perform the safety-related function of a nuclear air treatment, heating, ventilating, and air conditioning system.

Test Boundary -- the physical limits of the component, system, or device being subjected to a specified test.

Test Canister -- a specially designed sample holder containing adsorbent for laboratory tests that can be removed from an adsorber bank, without disturbing the remainder of the adsorber, to provide representative samples for laboratory testing.

ARTICLE TA-2000
REFERENCE DOCUMENTS

The reference documents listed below shall supplement those listed in AA-2000.

AMERICAN CONFERENCE OF GOVERNMENT INDUSTRIAL HYGIENISTS (ACGIH) INDUSTRIAL VENTILATION: A Manual of Recommended Practice.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
ASTM D 3803-1989, Standard Test Method for Nuclear Grade Activated Carbon.

AMERICAN NUCLEAR SOCIETY (ANS)
ANS 3.1 , Selection Qualification and Training of Nuclear Power Plant Personnel. (latest edition)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
ANSI/ASME NQA-1-1989
Quality Assurance Program Requirements for Nuclear Facilities.

ANSI/ASME NQA-2-1989
Quality Assurance Requirements for Nuclear Facility Applications.

SHEET METAL AND AIR-CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC (SMACNA)
HVAC Systems Testing, Adjusting, and Balancing 1983.

ASSOCIATED AIR BALANCE COUNCIL (AABC)
National Standard of Total System Balance 1989.

DEPARTMENT OF ENERGY, DOE Proceedings
16th DOE Nuclear Air Cleaning Conference, page 125, "Size Distribution of Aerosols Produced from Substitute Materials by the Laskin Cold DOP Aerosol Generator", February 1981, NTIS Springfield, VA. (W. Hinds, J. Macher, M. First).

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)
Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems 1991.

(**REFERENCES WILL BE UPDATED TO LATEST ADDITION PRIOR TO PUBLICATION**)

ARTICLE TA-3000
GENERAL INSPECTION AND TEST REQUIREMENTS

TA-3010 General

All inspections and tests shall be conducted in accordance with these requirements and the specific requirements of TA-4000.

NOTE: Activities in this section may involve the use of hazardous materials, operations and equipment. This section does not purport to address all of the safety requirements associated with their use. It is the responsibility of the user of this section to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.

TA-3100 TEST INSTRUMENTS

A calibration program shall be established in accordance with the Owner's Quality Assurance Program. All permanent and temporary test instruments used in the conduct of tests required by TA-4000 shall be in calibration. Instrument accuracy shall meet or exceed the requirements of Table TA-3000-1.

TABLE TA-3000-1
INSTRUMENT ACCURACY REQUIREMENTS

MEASUREMENT	RANGE	ACCURACY
Pressure	>1.0 psig (>7.0 kPa(gage))	+/- 2.0 %
Pressure	from 1.0 in wg to 1.0 psig (0.25 to 7.0 kPa(gage))	+/- 0.1 in wg (+/-0.025 kPa)
Pressure	from 0.1 in wg to 1.0 in wg (2.5 to 250 Pa(gage))	+/- 0.01 in wg (+/-2.5 Pa)
Temperature	variable	+/- 2.0 °F (+/- 1.0 °C)
Temperature*	variable	+/- 0.5 °F (+/- 0.25 °C)
Vibration	variable	Per TA-3141
Flow	variable	+/- 5.0 %
Velocity (airflow)	variable	+/- 3.0 %
Speed	variable	+/- 2.0 %
Time	variable	+/- 1.0 sec
Electrical voltage	variable	+/- 1.0 %
Electrical resistance	variable	+/- 1.0 %
Challenge aerosol concentration		Per TA-3142
Challenge gas concentration		Per TA-3143

* Required for pressure testing in mandatory Appendix TA-III.

TA-3110 Range Requirements

The full scale range of instruments shall be limited as necessary to ensure that the readings are within the accuracy requirements of Table TA-3000-1.

TA-3120 Instrument Fluctuation

Symmetrical damping devices or averaging techniques may be used to reduce random signal fluctuations. Hydraulic instruments may be damped by using gauge snubbers or by throttling valves in instrument lines.

TA-3130 Evaluation Following Test Instrument Loss, Damage or Calibration Failure

When a test instrument is lost, damaged, or otherwise fails to meet the requirements of Table TA-3000-1 during calibration, all test results obtained using the instrument shall be evaluated, dating back to the time of the previous calibration. If the evaluation does not confirm that the instrument met the acceptance criteria for the test(s) in question, the test(s) shall be repeated with calibrated instruments.

TA-3140 Specific Instrument Accuracy Requirements

TA-3141 Vibration Instrument

Vibration instrument accuracy shall be at least +/- 10%. The minimum frequency response range of the vibration measuring instrument shall be approximately one third of the minimum shaft speed. For rotating components, the maximum frequency response range shall be at least two times the rotational shaft speed of the component being measured. For reciprocating components, the maximum frequency response range shall be at least two times the speed of the crankshaft, times the number of unique planes occupied by a piston throw.

TA-3142 Challenge Aerosol Measuring Instrument

The Challenge Aerosol Measuring Instrument shall be verified to have a linear range of at least 10^5 times the threshold sensitivity of the instrument with an accuracy in accordance with the Facility Project Specifications and Owner's Quality Assurance Program.

TA-3143 Challenge Gas Measuring Instrument

The Challenge Gas Measuring Instrument shall be verified to be capable of distinguishing challenge gas from background and measuring challenge gas over a linear range of at least 10^5 times the threshold sensitivity of the instrument with an accuracy in accordance with the Facility Project Specifications and Owner's Quality Assurance Program.

TA-3200 REFERENCE VALUES

TA-3210 Establishment of Reference Values

Reference values shall be determined from results achieved during acceptance testing (TA-4000), when a component or system is proven to be operating within the acceptable limits of the Owner's Design Specification. Operating tests and inspections specified in TA-4000 shall be observed, measured, or calculated under conditions readily reproducible during subsequent in-service tests to allow for direct comparison of test results. All test results and associated analyses shall be included in the test procedure documentation (TA-6300).

TA-3300 INSPECTIONS AND TESTS

Acceptance tests shall be conducted following initial component installation but prior to releasing the system for normal operations. Applicable acceptance tests shall also be used to obtain new reference values and verify design function following component replacement, repair, modification, or maintenance. Equipment shall be evaluated as separate components and as functioning parts of an integrated system. The Owner shall define system test boundaries and evaluate system performance with respect to system functional requirements in accordance with the Owners Design Specifications. Field acceptance tests shall be implemented as applicable and in accordance with this section.

Test designations associated with tests required by TA-4000 are listed in Table TA-3000-2. Within the context of TA-4000, when a test is not associated with a Designator it shall be considered a prudent action and not a test requirement.

TABLE TA-3000-2
TEST DESIGNATIONS

TEST	DESIGNATOR
Air-Aerosol mixing test	AA
Airflow distribution test	AD
Differential pressure test	DP
Differential temperature test	DT
Flow rate test	Qf
Functional test*	F
Hydrostatic test	HYD
In-place leak test	IP
Laboratory analysis (adsorbent methyl-iodide penetration)	LAB
Electrical performance test	AMP
Leak test	PL
Structural capability test	PS
Rotational speed test	N
Bearing temperature test	Tb
Vibration test	Vb
Visual inspection	VT

* Functional tests consist of various mechanical actuation and performance verifications and are detailed separately in each test article.

TA-3310 Inspection and Test Parameters

Parameters which need to be observed, calculated and recorded in order to meet the requirements of this section shall be identified for each system based on the functional requirements of the Owner's Design Specification and shall be included in the test procedure documentation (TA-6300).

TA-3320 System Operating Conditions

Operating conditions required for acceptance testing shall be determined for each system. These conditions and acceptance criteria shall be based on the requirements of the Owner's Design Specification and shall be included in the test procedure documentation (TA-6300).

TA-3330 Procedure Requirements

The Owner shall be responsible for the development and implementation of written test procedures that meet the requirements of this section. Each equipment test section consists of generic (TA-3400) and specific (TA-4000) test requirements and acceptance criteria which apply to each of the systems in the facility. The Owner shall document which requirements are applicable in the test procedure documentation (TA-6300).

TA-3340 Test Reports

Test reports shall be prepared in accordance with TA-6300.

TA-3400 GENERIC TESTS

Generic tests as specified in TA-3410 through TA-3433 shall be used in Article TA-4000 where applicable.

TA-3410 Visual Inspection (VT)

Visual inspections shall be conducted in accordance with AA-5000 and the applicable portions of mandatory Appendix TA-I. Field acceptance visual inspections, required in TA-4000, shall include verification of component installation in accordance with the Owner's Design Specification and the applicable sections of this Code. Acceptance inspections shall be conducted prior to releasing the equipment for normal operation.

TA-3420 Pressure Boundary Tests

Pressure boundary tests consist of hydrostatic (or pneumatic) tests for hydronic systems, leak tests for refrigerant systems, and structural capability and leak tests for ducts and housings, including fan and damper housings.

TA-3421 Hydrostatic Tests (HYD)

Hydrostatic tests shall be conducted at the hydrostatic pressure defined by the Owner and shall verify that the component will not rupture, leak or be permanently deformed under design pressure loads. Testing shall be conducted in accordance with the design codes used in the Owner's Design Specification (e.g. ANSI/ASME B31.1). Pneumatic testing may be used in lieu of water where allowed by the applicable codes and in the Owner's Design Specification.

TA-3422 Structural Capability Test (PS)

Structural capability tests shall be conducted at the structural capability pressure defined by the Owner's Design Specification and shall verify that the component will not rupture or be permanently deformed under design pressure loads. Testing shall be conducted in accordance with mandatory Appendix TA-II.

TA-3423 Leak Test, Duct, Housing, and Frames (PL)

Leak tests for duct and housing sections shall be conducted using either the pressure decay method or the constant pressure method to verify that the leak rate for duct or housing does not exceed the allowable limit established for the system. Testing shall be conducted in accordance with mandatory Appendix TA-III. Leak testing performed to satisfy Section SA of this Code may be used to meet these test requirements when the test method is compatible with mandatory Appendix TA-III.

An optional leak test for HEPA filter and adsorber mounting frames is authorized to be conducted in conjunction with the housing leak test by blanking off the frame openings and pressurizing the isolated test boundary. This procedure is useful for detecting small leaks in the mounting frame during acceptance testing. This test is used to verify that there are no defects in a frame that may cause failure of the in-place leak test. Testing should be conducted in accordance with non-mandatory Appendix TA-A.

TA-3424 Leak Test, Refrigerant Piping and Coils (PL)

Leak tests of refrigerant piping and coils shall be conducted in accordance with mandatory Appendix TA-VIII.

TA-3430 Functional Tests (F)

A functional test shall be used to verify mechanical and system performance parameters of equipment. Functional tests include component and system tests as required in Article TA-4000. Component functional tests are used to verify the operational readiness of individual components. Integrated system functional tests are used to verify that all of the system components will operate together under normal operating or simulated conditions and will meet all of the performance requirements of the Owner's Design Specification.

TA-3431 Test Conditions

Equipment shall be tested within the normal operating range specified in the Owner's Design Specification except as otherwise specified in TA-4000.

TA-3432 Restoration of Function Following Testing

Mechanical and electrical equipment status shall be restored as required by plant conditions and according to approved procedures following completion of any test.

TA-3433 Vibration Test (Vb)

Vibration measurements shall be taken on the accessible motor, fan, compressor and pump bearing housings in at least two different orthogonal planes approximately perpendicular to the line of the rotating shaft. When the bearing housing is not accessible, the frame of the component may be used if it will be representative of bearing housing vibration. When portable vibration instruments are used, reference points shall be clearly identified on the component being measured to permit duplication in both location and plane.

TA-3500 ACCEPTANCE CRITERIA

Results of tests described in Article TA-4000 shall be subject to the acceptance criteria in TA-3510 through TA-3530 and to the applicable operating and design criteria specified by the Owner's Design Specification. Test results are considered acceptable if the component or system is not impaired or degraded to the point that it cannot perform its intended function. Acceptance criteria are specified in TA-4000 only when they affect the quality of other tests. When test results do not meet the applicable acceptance criteria, the corrective actions required by TA-5000 shall be initiated.

TA-3510 Visual Inspection

Visual inspections are acceptable when there are no visual indications of improper installation, physical damage, structural distress or degradation that would impair the ability of a component or system to perform its intended function.

TA-3520 Pressure Boundary Tests

Pressure boundary tests are acceptable when there is no permanent structural deformation or leaks in excess of the limits specified in the applicable sections of this Code and the Owner's Design Specification.

TA-3530 Functional Tests

Functional tests are acceptable when they meet the requirements of the applicable sections of this Code and the Owner's Design Specification.

ARTICLE TA-4000
FIELD ACCEPTANCE TESTS

TA-4010 General

Field acceptance tests shall be conducted following initial system installation but prior to releasing the equipment for normal operation. Applicable inspections and tests shall be conducted to verify compliance with the Owner's Design Specifications following equipment replacement, repair, modification, maintenance, or abnormal incident. Within the context of Article TA-4000, a test not associated with a test designator is considered to be a prudent action and not a test requirement.

TA-4100 FAN ACCEPTANCE TESTS

This section provides the field acceptance test requirements for fans, motors, and related accessories. Integrated system testing shall be conducted in accordance with TA-4900.

TA-4101 Acceptance Test Requirements

Acceptance tests shall be conducted with the fan operating at a flow rate within the normal operating range for the system. The tests listed in Table TA-4000-1 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Section BA of this code, and as required in TA-3500 and TA-4150. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison during periodic in-service tests.

TABLE TA-4000-1
FAN ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Structural capability test	PS	*	
Leak tests	PL	*	
System flow balance test	F	*	
Mechanical run test	F		*
Flow rate test	Qf	*	
Differential Pressure test	DP	*	
Electrical test	AMP	*	
Rotational speed test	N	*	
Vibration test	Vb	*	
Bearing temperature test	Tb	*	
Fan performance test	F	*	

TA-4110 Visual Inspection (VT)

A visual inspection of the fan and associated components shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1100).

TA-4120 Pressure Boundary Tests

TA-4121 Structural Capability Test (PS)

When a fan housing is part of the system pressure boundary, a structural capability test shall be conducted to verify structural capability of the fan housing and connections in accordance with TA-3422 and mandatory Appendix TA-II. The fan housing may be tested concurrent with the duct and housing structural capability test specified in TA-4321.

TA-4122 Leak Test, Fan Housing (PL)

When a fan housing is part of the system pressure boundary, a pressure boundary leak test shall be conducted to verify the leak tightness of the fan housing and attached interfaces in accordance with TA-3423 and mandatory Appendix TA-III. The fan housing may be tested concurrent with the duct and housing leak test specified in TA-4322.

TA-4123 Leak Test, Fan Shaft Seal (PL)

When a fan shaft seal is part of the system pressure boundary, a pressure boundary leak test shall be conducted to verify the leak tightness of the shaft seal in accordance with TA-3423 and mandatory Appendix TA-III. The shaft seal may be tested concurrent with the duct and housing leak test specified in TA-4322. However, the shaft seal leakage rate shall be evaluated (qualitatively) independent of the overall system leak rate. The qualitative evaluation of the leakage shall be included in the test report.

TA-4130 Component Functional Tests

The following prerequisites shall be conducted on the fan and motor assemblies prior to the system functional tests specified in TA-4140.

TA-4131 Electrical Prerequisites

Prior to the initial energizing of the fan, the electrical power circuits shall be checked for installation, circuit continuity, voltage capacity and protective relay device settings.

TA-4132 Control System Prerequisites

Prior to the initial energizing of the fan, controls shall be calibrated and verified operational.

TA-4133 Startup Prerequisites

Prior to the initial energizing of the fan, the fan and motor shaft shall be manually rotated to verify moving parts are free of interference. The motor shall be momentarily energized to verify correct rotational direction. The fan shall be restarted and stable operation (no surging) verified. Fan and motor vibration, bearing temperature, motor electrical amperage and phase balance, fan speed, differential pressure, and airflow shall be monitored. Following one hour of operation, or immediately after observation of unusual performance (i.e. unstable performance), the fan shall be secured and a detailed visual inspection for signs of damage or degradation shall be conducted.

TA-4140 System Functional Tests

This section provides the system level field acceptance test requirements for fan systems.

TA-4141 System Flow Balance Test (F)

A system flow balance shall be conducted. Recommended procedures include SMACNA, NEBB, ACGIH, OR AABC (reference TA-2000).

System flow balancing may be conducted using artificial resistance in lieu of filters. However, final component reference values shall be obtained with clean system components installed.

TA-4142 through TA-4149 shall be conducted in the same time frame.

TA-4142 Mechanical Run Test (F)

Prior to conducting the tests specified in TA-4143 through TA-4149, the fan shall be operated at the design flow rate for at least 15 minutes and stable system operation (no surging) verified.

TA-4143 Flow Rate Test (Qf)

The fan flow rate shall be measured. Recommended procedures include ACGIH "Industrial Ventilation" or equivalent.

TA-4144 Static Pressure Test (DP)

The fan inlet and outlet static pressure and velocity pressure shall be measured and the overall fan static pressure determined.

TA-4145 Electrical Tests (AMP)

The fan motor supply voltage and amperage shall be measured for each phase.

TA-4146 Rotational Speed Test (N)

The rotational speed of the fan shall be measured.

TA-4147 Vibration Test (Vb)

The vibration of each fan and motor bearing shall be measured in accordance with TA-3433.

TA-4148 Bearing Temperature Test (Tb)

Following bearing temperature stabilization, the fan and motor bearing temperatures shall be measured. Stabilization occurs when temperature changes are less than or equal to +/- 3 °F (1.5 °C) in a 10 minute period.

TA-4149 Fan Performance Test (F)

For systems with filter or adsorber banks, the fan performance shall be measured under maximum design dirty filter conditions. This may be done by increasing the system resistance to the design dirty filter differential pressure, (design basis maximum dirty filter condition), using artificial resistance. The measurement procedures in TA-4142 through TA-4148 shall be used.

TA-4150 Acceptance Criteria

The following acceptance criteria are in addition to the requirements of TA-3500.

TA-4151 Airflow Capacity Test Acceptance Criteria

Airflow capacity shall be within +/- 10% of design when tested in the normal clean and maximum dirty filter conditions.

TA-4152 Fan Performance Acceptance Criteria

Fan performance (flow, static pressure, horsepower) shall meet the specifications of the manufacturer's fan performance curve and the Owner's Design Specification.

TA-4200 DAMPER ACCEPTANCE TESTS

This section provides the field acceptance test requirements for dampers and related accessories. Integrated system testing shall be conducted in accordance with TA-4900.

TA-4201 Acceptance Test Requirements

Acceptance tests shall be conducted with the dampers installed in the system. The tests listed in Table TA-4000-2 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Section DA of this code, and as required in TA-3500. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TA-4210 Visual Inspection (VT)

A visual inspection of the damper and associated components shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1200).

TABLE TA-4000-2
DAMPER ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Structural capability tests	PS	*	
Leak tests	PL	*	
Position indication test	F	*	
Exercise test	F		*
Static timing test	F	*	
Flow Control test	F		*
Fire Damper test	F		*
Dynamic time test	F	*	
Interlock Test	F		*

TA-4220 Pressure Boundary Tests.

TA-4221 Structural Capability Test, Damper Housing (PS)

When the damper housing and actuator shaft seal are part of the system pressure boundary, a structural capability test shall be conducted to verify the structural capability of the damper housing, shaft seal, and interfaces in accordance with TA-3422 and mandatory Appendix TA-II. The damper housing may be tested concurrent with the duct and housing structural capability test specified in TA-4321.

TA-4222 Structural Capability Test, Damper Blades (PS)

Isolation dampers shall be tested to verify the structural capability of the damper blade and seat in accordance with TA-3422 and mandatory Appendix TA-II. The damper blades and seat may be tested concurrent with the duct and housing structural capability test specified in TA-4321.

TA-4223 Leak Test, Damper Housing (PL)

When a damper housing is part of the system pressure boundary, a pressure boundary leak test shall be conducted to verify leak tightness of the damper housing and interfaces in accordance with TA-3423 and mandatory Appendix TA-III. The damper housing may be tested concurrent with the duct and housing leak test specified in TA-4322.

TA-4224 Leak Test, Damper Shaft Seal (PL)

When a damper shaft seal is part of the system pressure boundary, a pressure boundary leak test shall be conducted to verify leak tightness of the shaft seal in accordance with TA-3423 and mandatory Appendix TA-III. The shaft seal may be tested concurrent with the duct and housing leak test specified in TA-4322. However, the shaft seal leak rate shall be evaluated (qualitative) independently of the overall system leak rate. The qualitative evaluation of the leakage shall be included in the test report.

TA-4225 Leak Test, Damper Seat (PL)

When dampers have seat leakage limits, a leak test shall be conducted in the direction the damper is expected to function, in accordance with TA-3423 and mandatory Appendix TA-III. The seat leak rate shall be tested by blanking off or otherwise isolating a duct section upstream of the damper. The leak test shall be performed with the damper cycled closed using its normal closing mechanism (without any additional manual assistance).

TA-4230 Component Functional Tests

Component functional tests shall verify that the damper is operational prior to conducting the system functional tests specified in TA-4240.

TA-4231 Electrical Prerequisites

Prior to the initial energizing of the damper operator, the electrical circuits shall be checked for proper installation, circuit continuity, voltage capacity and protective relay device settings.

TA-4232 Pneumatic Prerequisites

Prior to the initial pressurizing of the damper control system, pneumatic systems shall be checked for proper installation and leak tightness.

TA-4233 Control System Prerequisites

Prior to the initial energizing of the damper operator, control instrumentation shall be calibrated and verified to be operational.

TA-4234 Position Indication Test (F)

Dampers having remote position indicators shall be observed during operation to verify that the mechanical damper position corresponds to the remote indication.

TA-4235 Exercise Test (F)

Power operated dampers shall be fully cycled using a control switch or other actuating device to verify operation. Manual dampers, including balancing dampers, shall be fully cycled to verify operation. Fire Dampers shall be tested in accordance with TA-4242.

TA-4236 Static Timing Test (F)

Power operated dampers (electrical or pneumatic), that are required to operate within a specified time limit, shall be tested by measuring time for the damper to fully open or fully close (as required by the Owner's Design Specification).

TA-4240 System Functional Tests

TA-4241 Flow Control Damper Functional Test (F)

Power operated dampers that control air flow shall be observed under throttled (throughout its anticipated operating range) flow conditions to verify free movement and stable operation.

TA-4242 Fire Damper Test (F)

Fire dampers shall be tested, using a normal or simulated actuation signal, to verify activation under design airflow conditions.

TA-4243 Dynamic Timing Test (F)

Isolation dampers having a required actuation response time shall be timed to the fully open or fully closed position (as required by the Owners Design Specification) under design airflow conditions.

TA-4244 Interlock Test (F)

Dampers that have an opening or closing function interlocked with other components (e.g. fans, other dampers) shall be tested to verify interlock action.

TA-4300 DUCT, HOUSING, AND MOUNTING FRAME ACCEPTANCE TESTS

This section provides the field acceptance test requirements for ducts, housings and mounting frames.

TA-4301 Acceptance Test Requirements

Acceptance tests shall be conducted with the ducts, housings and mounting frames installed in the system. The tests listed in Table TA-4000-3 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Section SA of this Code, and as required in TA-3500. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TA-4310 Visual Inspection (VT)

A visual inspection of ducts, housings, and mounting frames, shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1300).

TABLE TA-4000-3
DUCT, HOUSING AND FRAME ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Structural capability test	PS	*	
Leak tests	PL	*	

TA-4320 Pressure Boundary Tests

Pressure boundary tests apply to all ducts, housings and interface connections that are parts of the system. Individual components may be tested at separate times provided that all system pressure boundaries are ultimately tested prior to the system being placed into service.

TA-4321 Structural Capability Test, Duct and Housing (PS)

A structural capability test shall be conducted to verify structural capability of ducts and housings in accordance with TA-3422 and mandatory Appendix TA-II.

TA-4322 Leak Test, Duct and Housing (PL)

A pressure boundary leak test shall be conducted to verify leak tightness of the ducts and housings in accordance with TA-3423 and mandatory Appendix TA-III.

TA-4323 Leak Test, Mounting Frame (optional) (PL)

A mounting frame pressure leak test may be used to detect leaks in the HEPA filter and adsorber mounting frames that could affect the results of the in-place leak tests in TA-4600 and TA-4700. This test is optional and may be conducted in accordance with non-mandatory Appendix TA-A.

TA-4400 REFRIGERATION EQUIPMENT ACCEPTANCE TESTS

This section provides the field acceptance test requirements for refrigeration equipment. Integrated system testing shall be conducted in accordance with TA-4900.

TA-4401 Acceptance Test Requirements

Acceptance tests shall be conducted with the refrigeration equipment in service under normal operating conditions. The tests listed in Table TA-4000-4 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, applicable portions of Section RA of this Code, and as required in TA-3500. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TA-4410 Visual Inspection (VT)

A visual inspection of the refrigeration equipment components shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1400).

TA-4420 Pressure Boundary Tests

TA-4421 Leak Test, Refrigerant Piping and Coil (PL)

Refrigeration systems, including piping, coils, and pressure vessels, shall have a pressure test conducted to verify structural integrity and leak tightness. Testing shall be conducted in accordance with TA-3424 and mandatory Appendix TA-VIII.

TABLE TA-4000-4
REFRIGERATION EQUIPMENT ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Leak test	PL		*
Hydrostatic test	HYD		*
Valve position indication test	F		*
Valve exercise test	F		*
Valve timing test	F	*	
Flow Control valve test	F		*
Mechanical run test	F		*
Performance test	F	*	
Electrical test	AMP	*	
Rotational speed test	N	*	
Vibration test	Vb	*	
Bearing temperature test	Tb	*	

TA-4422 Hydrostatic Test, Hydronic Piping and Coils (HYD)

Hydronic piping, coils and pressure vessels, shall have a hydrostatic test conducted to verify structural integrity and leak tightness. Testing shall be conducted in accordance with TA-3421.

TA-4430 Component Functional Tests

The following component functional tests and prerequisites shall be conducted to verify that the refrigeration system equipment is operating acceptably prior to conducting the system functional tests specified in TA-4440. Fans shall be tested in accordance with TA-4100.

TA-4431 Electrical Prerequisites

Prior to the initial energizing of the refrigeration system components, the electrical circuits shall be checked for installation, circuit continuity, voltage capacity, and protective relay device settings.

TA-4432 Control System Prerequisites

Prior to the initial energizing of the refrigeration system components, the system controls shall be calibrated and verified operational.

TA-4433 Valve Position Indication Test (F)

Valves having remote position indicators shall be observed during valve full stroke operation to verify that the valve position corresponds to the remote indication.

TA-4434 Valve Exercise Test (F)

Power operated valves shall be fully cycled using a control switch or other actuating device to verify operation. Manual valves shall be fully cycled to verify operation.

TA-4435 Valve Timing Test (F)

Power operated valves that are required to operate within a specified time limit shall be tested by measuring the time to fully cycle.

TA-4436 Startup Prerequisites

The compressor motor shall be momentarily energized and correct direction of rotation verified. restart the compressor motor,verify stable operation and monitor the compressor motor electrical supply voltage, amperage and phase balance, vibration, bearing temperatures, and rotational speed, as applicable. Following one hour of operation, or immediately after observation of unusual performance (unstable operation), the equipment shall be secured and a detailed visual inspection conducted for signs of damage or degradation.

TA-4440 System Functional Tests

The refrigeration equipment shall be tested to verify mechanical component integrity and design cooling function. TA-4441 through TA-4447 shall be conducted in the same time frame.

TA-4441 Flow Control Valve Test (F)

Power operated valves, controlled by flow instrumentation, shall be observed under throttled (throughout its anticipated operating range) flow conditions to verify freedom of movement, stable operation, and ability to maintain required flow.

TA-4442 Mechanical Run Test (F)

The refrigeration compressor shall be operated with the system in the normal heat load range for at least 15 minutes and stable system operation verified.

TA-4443 Performance Test (F)

The refrigeration compressor inlet and outlet pressure and temperature shall be measured with the equipment operating at achievable load points.

TA-4444 Electrical Test (AMP)

The compressor motor electrical supply voltage and amperage shall be measured for each phase.

TA-4445 Rotational Speed Test (N)

The rotational speed of the compressor shall be measured when accessible.

TA-4446 Vibration Test (Vb)

The vibration of each accessible bearing on the compressor and compressor motor shall be measured in accordance with TA-3433.

TA-4447 Bearing Temperature Test (Tb)

Following compressor and compressor motor bearing temperature stabilization, the accessible bearing temperatures shall be measured. Stabilization occurs when temperature changes are less than or equal to +/- 3 °F (1.5 °C) in a 10 minute period.

TA-4500 CONDITIONING EQUIPMENT ACCEPTANCE TESTS

This section provides the field acceptance test requirements for forced circulation air cooling and heating coils, air washers, evaporative coolers, and electric heating coils. Integrated system testing shall be conducted in accordance with TA-4900.

TA-4501 Acceptance Test Requirements

Acceptance tests shall be conducted with the conditioning equipment in service under normal operating conditions for the system . The tests listed in Table TA-4000-5 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Section CA of this Code, and as required in TA-3500 and TA-4560. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TABLE TA-4000-5
CONDITIONING EQUIPMENT ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Hydrostatic test	HYD		*
Electric heater step controller test	F		*
Electric heater coil resistance test	F	*	
Electric heater resistance to ground test	F	*	
Valve performance tests	F	*	*
Performance test	F	*	
Electrical test	AMP	*	
Rotational speed test	N	*	
Vibration test	Vb	*	
Bearing temperature test	Tb	*	
Electric heater performance test	F	*	
Hydronic system flow balance	F	*	
Hydronic system heater and coil performance test	F	*	
Air washer, evaporative cooler performance test	F	*	

TA-4510 Visual Inspection (VT)

A visual inspection of the conditioning equipment components shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1500).

TA-4520 Pressure Boundary Tests

TA-4521 Hydrostatic Test, Hydronic Piping and Coils (HYD)

Hydronic piping, coils and pressure vessels shall have a hydrostatic test conducted to verify structural integrity and leak tightness. Testing shall be conducted in accordance with TA-3421.

TA-4530 Component Functional Tests

The following component functional prerequisites and tests shall be conducted to verify that the conditioning system equipment is operating acceptably prior to conducting the system functional tests specified in TA-4540. Fans shall be tested in accordance with TA-4100. Refrigeration components shall be tested in accordance with TA-4400.

TA-4531 Electrical Prerequisites

Prior to the initial energizing of the conditioning system equipment, the electric circuits shall be checked for proper installation, circuit continuity, voltage capacity, and protective relay device settings.

TA-4532 Control System Prerequisites

Prior to the initial energizing of the conditioning system components, the controls shall be calibrated and verified operational.

TA-4533 Electric Heater Step Controller Test (F)

Electric heater step controllers shall be tested by initiating a simulated demand signal to verify the heater circuit step controller is operational.

TA-4534 Electric Heater Coil Resistance Test (F)

The electrical resistance shall be measured across each heater circuit in accordance with CA-5440.

TA-4535 Electric Heater Resistance To Ground Test (F)

The electrical resistance to ground shall be measured on each heater circuit.

TA-4536 Valve Performance Tests (F)

Conditioning system valves shall be tested in accordance with TA-4433, TA-4434, and TA-4435.

TA-4537 Startup Prerequisites

Prior to starting the conditioning system pumps, the pump shaft shall be manually rotated to verify freedom of movement. The motor shall be momentarily energized and the correct direction of rotation verified. restart the pump motor and verify stable operation and monitor the pump motor electrical supply voltage, amperage and phase balance, bearing vibration, bearing temperatures, rotational speed, pump differential pressure, and fluid system flow rate, as applicable. Following one hour of operation, or immediately after observation of unusual performance (unstable operation), the pump shall be secured and a detailed visual inspection for signs of damage or degradation conducted.

TA-4540 System Functional Tests

The conditioning equipment shall be tested in conjunction with the system to verify mechanical component integrity and design cooling or heating function. TA-4541 through TA-4546 shall be conducted in the same time frame.

TA-4541 Hydronic System Flow Balance Test (F)

A hydronic system flow balance shall be conducted. Recommended procedures include SMACNA, NEBB, or AABC (reference TA-2000).

TA-4542 Flow Control Valve Test (F)

Power operated valves, controlled by flow control instrumentation, shall be observed under throttled (throughout its anticipated operating range) flow conditions to verify freedom of movement, stable operation, and the ability to maintain required flow.

TA-4543 Mechanical Run Test (F)

The conditioning system pumps shall be operated with the system operating in the normal operating range for at least 15 minutes and stable system operation (no surging) verified.

TA-4544 Performance Test (F)

The conditioning system pump differential pressure and flow rate shall be measured with the pump operating at achievable flow rates.

TA-4545 Electrical Tests (AMP)

The conditioning system pump supply voltage and amperage shall be measured for each phase.

TA-4546 Rotational Speed Test (N)

The rotational speed of the pump shaft shall be measured.

TA-4547 Vibration Test (Vb)

The vibration of each bearing on the pump and motor shall be measured in accordance with TA-3433.

TA-4548 Bearing Temperature Test (Tb)

Following pump and motor bearing temperature stabilization, the bearing temperature shall be measured. Stabilization occurs when temperature changes are less than or equal to +/- 3 °F (1.5 °C) in a 10 minute period.

TA-4549 Electric Heater Performance Test (F)

With design airflow (+/- 10%) through the heater bank, the electrical supply voltage, amperage, and phase balance of each heater circuit, and differential temperature and air flow across the heater bank shall be measured. Following one hour of continuous operation, the heater shall be secured and a detailed visual inspection shall be conducted for signs of damage or degradation.

TA-4550 Hydronic System Heating and Cooling Performance Test (F)

With the conditioning system operating at design airflow (+/- 10%) and design hydronic flow (+/- 10%) and at achievable heat load conditions, the air-side flow, differential temperature and differential pressure, and the hydronic side flow, differential temperature and differential pressure shall be measured.

TA-4551 Air Washer, Evaporative Cooler Performance Test (F)

A performance test for the conditioning system air washers and evaporative coolers shall be conducted in accordance with CA-5000, Appendix CA-II.

TA-4560 Acceptance Criteria

The following acceptance criteria are in addition to TA-3500.

TA-4561 Electrical Heater Ground Resistance Acceptance Criteria

Conditioning system electric heater resistance to ground shall be greater than 50,000 Ohms.

TA-4600 MOISTURE SEPARATOR, PRE-FILTER, HEPA FILTER BANK ACCEPTANCE TESTS

This section provides the field acceptance test requirements for installed moisture separator, pre-filter and HEPA filter banks.

TA-4601 Acceptance Test Requirements

Acceptance tests shall be conducted with clean moisture separator, pre-filter and HEPA filter banks installed in the system. The tests in Table TA-4000-6 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Sections FA, FB and FC of this Code and as required in TA-3500 and TA-4630. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TABLE TA-4000-6
MOISTURE SEPARATOR, PREFILTER AND HEPA FILTER
ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Differential pressure test	DP	*	
Airflow distribution test	AD	*	
Air-aerosol mixing test	AA	*	
In-place leak test @	IP	*	

@ In-place leak tests are not required on systems used for 100% recirculation (e.g. Reactor containment cleanup units) unless the atmospheric cleanup rate is time dependent.

TA-4610 Visual Inspection (VT)

A visual inspection of the installed moisture separator, prefilter and HEPA filter banks shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1600).

TA-4620 System Functional Tests

TA-4621 Differential Pressure Test (DP)

With the system operating at design flow rate (+/- 10%), the differential pressure across each moisture separator, pre-filter, and HEPA filter bank shall be measured.

TA-4622 Airflow Distribution Test (AD)

With the system operating at design flow rate (+/- 10%), the airflow distribution shall be measured downstream of each moisture separator, prefilter, and HEPA filter bank in accordance with mandatory Appendix TA-IV.

TA-4623 Air-Aerosol Mixing Test (AA)

With the system operating at design flow rate (+/- 10%), the air-aerosol mixing upstream of each HEPA filter bank shall be measured in accordance with mandatory Appendix TA-V.

TA-4624 In-Place Leak Test (IP)

With the system operating at design flow rate (+/- 10%), the challenge aerosol leak rate of each HEPA filter bank shall be measured in accordance with mandatory Appendix TA-VI.

TA-4630 Acceptance Criteria

The following acceptance criteria are in addition to the requirements of TA-3500.

TA-4631 Airflow Distribution Test Acceptance Criteria

With the system operating within +/-10% of design flow rate, the variation in velocity measurements across the HEPA filter banks shall be limited to +/-20% of the average, when measured in accordance with mandatory Appendix TA-IV. Airflow distribution across the moisture separator and prefilter banks shall be in accordance with the Owner's Design Specification.

TA-4632 Air-Aerosol Mixing Test Acceptance Criteria

With the system operating within +/-10% of design flow rate, the variation in concentration of the air-aerosol mixture immediately upstream of the HEPA filter bank shall be limited to +/-20% of the average when measured in accordance with mandatory Appendix TA-V.

TA-4700 TYPE II and TYPE III ADSORBER BANK ACCEPTANCE TESTS

This section provides the field acceptance test requirements for installed type II and III adsorber banks.

TA-4701 Acceptance Test Requirements

Acceptance tests shall be conducted with the adsorbent media installed and in service under normal operating conditions for the system. The tests listed in Table TA-4000-7 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Sections FD and FE of this code, and as required in TA-3500 and TA-4730. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TABLE TA-4000-7
TYPE II AND TYPE III ADSORBER BANK ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Differential pressure test	DP	*	
Airflow distribution test	AD	*	
Air-aerosol mixing test	AA	*	
In-place leak test @	IP	*	
Test canister flow rate test	Qf	*	
Air heater performance test	F	*	

@ In-place leak tests are not required on systems used for 100% recirculation (e.g. Reactor containment cleanup units) unless the atmospheric cleanup rate is time dependent.

TA-4710 **Visual Inspection (VT)**

A visual inspection of the type II and type III adsorber banks shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1700).

TA-4720 **Component Functional Tests**

TA-4721 **Electric Heater Step Controller Test (F)**

Electric heater step controllers shall be tested by initiating a simulated demand signal to verify the heater circuit step controller is operational.

TA-4722 **Electric Heater Coil Resistance Test (F)**

The electrical resistance shall be measured across each heater circuit in accordance with CA-5440.

TA-4723 **Electric Heater Resistance To Ground Test (F)**

The electrical resistance to ground shall be measured on each heater circuit.

TA-4730 **System Functional Tests**

TA-4731 **Differential Pressure Test (DP)**

With the system operating at design flow rate (+/- 10%), the differential pressure across each adsorber bank shall be measured.

TA-4732 **Airflow Distribution Test (AD)**

With the system operating at design flow rate (+/- 10%), the airflow distribution across each adsorber bank shall be measured in accordance with mandatory Appendix TA-IV.

TA-4733 **Air-Aerosol Mixing Test (AA)**

With the system operating at design flow rate (+/- 10%), the air-aerosol mixing immediately upstream of each adsorber bank shall be measured in accordance with mandatory Appendix TA-V. This test is not required when it can be determined that the air-aerosol test conducted on a HEPA bank immediately upstream of the adsorber bank also provides equivalent challenge to the adsorber bank.

TA-4734 **In-Place Leak Test (IP)**

With the system operating at design flow rate (+/- 10%), the challenge gas leak rate of each adsorber bank shall be measured in accordance with mandatory Appendix TA-VII.

TA-4735 Test Canister Flow Rate Test (Qf)

When the system is equipped with test canisters used for obtaining adsorbent samples for laboratory analysis, the velocity through each test canister shall be measured (or calculated from flow measurements) with the system operating at design airflow rate. Alternatively, when access is limited and measurements cannot be performed, the design documentation shall be verified to assure that the installed canisters meet the performance requirements, (differential pressure / flow rate), of canisters used during shop testing of the test canister sampling system.

TA-4736 Electric Heater Performance Test (F)

With design airflow (+/- 10%) through the heater bank, the electrical supply voltage, amperage, and phase balance of each heater circuit, and differential temperature and air flow across the heater bank shall be measured. Following one hour of continuous operation, the heater shall be secured and a detailed visual inspection shall be conducted for signs of damage or degradation.

TA-4740 Acceptance Criteria

The following acceptance criteria are in addition to the requirements of TA-3500.

TA-4741 Airflow Distribution Test Acceptance Criteria

With the system operating within +/- 10% of design flow rate, the variation in velocity measurements across the face of the adsorber banks shall be limited to +/-20% of the average, when measured in accordance with mandatory Appendix TA-IV.

TA-4742 Air-Aerosol Mixing Test Acceptance Criteria

With the system operating within +/-10% of design flow rate, the variation in the challenge gas or aerosol concentration readings immediately upstream of each adsorber bank shall be limited to +/-20% of the average when measured in accordance with mandatory Appendix TA-V.

TA-4743 Test Canister Flow Rate Test Acceptance Criteria

The test canister velocity shall be within +/- 10% of the average adsorber design velocity as specified by the Owner's Design Specification.

TA-4800 ADSORBENT ACCEPTANCE TESTS

This section provides the Laboratory acceptance test requirements for radioactive iodine penetration of the adsorbent used in adsorber systems.

TA-4801 Acceptance Test Requirements

A laboratory acceptance test shall be conducted using representative samples of adsorbent from the adsorber system. This test measures the radioiodine penetration of the adsorbent. Laboratory test results shall be evaluated to the acceptance limits of the Owner's Design Specification. Sample locations shall be documented to ensure they are not reused in periodic in-service testing. Test Results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TA-4810 Laboratory Analysis of Adsorbent (LAB)

New adsorbent installed in the adsorber banks shall be certified in accordance with the manufacturers test data for radioiodine penetration (ref. FF-5000). Adsorbent stored more than 50 percent of manufacturer's assigned shelf life shall have a laboratory test conducted in accordance with ASTM D-3803-89 prior to installation. The test bed depth, air temperature, humidity, and flow rate, used in the laboratory test, shall be the same as adsorber bank conditions required by the Owner's Design Specification. Adsorbent installed in the adsorber bank shall be sampled and tested in accordance with the procedures in ASTM D-3803-89 prior to system operation.

TA-4900 INTEGRATED SYSTEM TESTS

Each system shall be tested to verify the functional performance at achievable design operating conditions. Integrated system tests shall be conducted to challenge all integrated control functions including interlocks and manual or automatic actuation circuits, (damper position changes, fan starts and stops, compressor and pump starts or stops, valve position changes, heater energization or de-energization). Actuations can be from a number of different sources including radiation sensors, temperature sensors, chlorine sensors, pressure sensors, manual controls and emergency safeguard signals. Sensor operation shall be verified in addition to control circuitry. Integrated testing shall also include an overall system leak test to verify that there are no unacceptable bypasses of the HEPA filter or adsorber banks. Integrated system testing shall verify that the intended design function of the system is achieved in accordance with the Owner's Design Specification. Test results shall be documented in accordance with TA-6300.

TA-4910 Fan Integrated System Test Requirements (F)

Fans designed to respond automatically to a process or emergency actuation signal shall be tested. Sequencing of starts, stops and speed changes shall be conducted utilizing an actual or simulated actuation signal.

TA-4920 Damper Integrated System Test Requirements (F)

Dampers designed to respond automatically to a process or emergency actuation signal shall be tested. Sequencing of damper position changes shall be conducted utilizing an actual or simulated actuation signal.

TA-4930 Refrigeration and Conditioning Integrated System Test Requirements (F)

Refrigeration and Conditioning equipment designed to respond automatically to a process or emergency actuation signal shall be tested. Sequencing of equipment operation (starts, stops, speed changes, valve operations or isolation, heater operation) shall be conducted utilizing an actual or simulated actuation signal.

TA-4940 HEPA and Adsorber Bank Integrated System Test Requirements (F)

All potential HEPA filter and adsorber bank bypass flow paths shall be challenged to verify that leak rates are within the Owner's Design Specification. Bypass flow paths may be challenged during the in-place leak test specified in TA-4624 and TA-4734, by ensuring that the challenge aerosol or gas injection and sample ports encompass all potential bypass flow paths (reference mandatory appendix TA-V, step V-1100). If a potential bypass flow path within the system is not challenged during these in-place tests, a separate test shall be performed using mandatory appendix TA-VI or TA-VII to verify that the HEPA or adsorber banks are not being bypassed in excess of the limits specified in the Owner's Design Specification.

ARTICLE TA-5000
CORRECTIVE ACTION REQUIREMENTS

Corrective action is required when test results do not meet the acceptance criteria specified in the applicable section or in the Owner's Design Specifications. For equipment that is replaced, modified, repaired, or has undergone maintenance, such that reference values may change, a new set of reference values shall be obtained in accordance with the requirements of Article TA-3200. Additional guidance for corrective actions is included in non-mandatory Appendix TA-B.

ARTICLE TA-6000
QUALITY ASSURANCE

TA-6100 General

Field testing of nuclear air treatment, heating, ventilating, and air conditioning systems shall be conducted in accordance with the quality assurance requirements of Article AA-8000, ANSI/ASME NQA-1, and ANSI/ASME NQA-2.

TA-6200 Personnel

Tests shall be conducted by personnel who have demonstrated competence to perform the specific tests, as evidenced by documented experience and training. Personnel shall be certified in accordance with ANSI/ASME NQA-1 or ANS 3.1, and in accordance with the Owner's Requirements.

TA-6300 Documentation

TA-6310 Procedures

Written acceptance test procedures shall document the field acceptance testing performed and test results obtained as specified in Article TA-4000. These records shall be maintained for the life of the facility.

TA-6320 Reports

A written report shall be provided to document the acceptance testing performed in accordance with Article TA-4000. The report shall contain the following as a minimum:

(a) The system name, test/inspection procedure(s) used, date of test results and the test performer's signature;
(b) Identification of instruments, equipment, tools and documents to the extent that they or their equivalents can be identified for future examinations;
(c) Observations and dimensional checks specified by the respective test data and reports developed during inspection and testing;
(d) Conclusions and recommendations by visual examination and testing personnel;
(e) Reference to previous reports if this report is for reinspection and testing.

APPENDIX TA-I
MANDATORY
VISUAL INSPECTION CHECKLIST

I-1000 General

A specific inspection checklist for each component in the system shall be included in the acceptance test procedures. This Appendix lists typical items for each component that need to be inspected visually in Article TA-4000 (Acceptance tests). As a minimum, the lists of items indicated below shall be checked for compliance with the Owner's Specifications. The inspection shall be conducted in accordance with TA-3410. The acceptance criteria for these inspections shall be in accordance with TA-3500 and TA-3510.

I-1100 Fan Inspection Checklist

a. Housing and duct interface
b. Fan belt and shaft guards
c. Interferences with moving parts
d. Fan shaft seal
e. Belt adjustment and condition
f. Lubricant levels
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Control system components
l. Pneumatic connections
m. As built configuration in accordance with design drawings
n. Fan nameplate
o. Access for tests and maintenance

I-1200 Damper Inspection Checklist

a. Housing and duct interface
b. Actuator linkage, motor, controller
c. Interferences with moving parts
d. Damper shaft seal
e. Blade edge seals, damper seat
f. Limit switches
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Pneumatic connections
l. As built configuration in accordance with design drawings
m. Damper nameplate
n. Access for tests and maintenance

I-1300 Duct, Housing and Mounting Frame Inspection Checklist

a. Housing and duct connections (no caulking)
b. Provision for opening access doors from both inside and outside
c. Access door seals, gaskets
d. Access door latches
e. Housing internal access ladders and platforms
f. Sample and injection ports, location and caps
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation, connections
j. Electrical connections
k. Housing/duct penetration seals
l. Loop seals (water level), drain connections
m. Lighting conduits, socket housing seals (flush mounted)
n. HEPA/adsorber mounting frame continuous seal welds
o. Mounting frame penetrations seal welded
p. Mounting frame seating surface (weld splatter, flatness, scratches)
q. Sample canister installation
r. Mounting frame clamping devices
s. As built configuration in accordance with design drawings
t. Access for tests and maintenance
u. Lighting for test and maintenance available

I-1400 Refrigeration Equipment Inspection Checklist

a. Housing or duct interface with refrigeration equipment
b. Fan, pump, compressor belt and coupling guards
c. Interferences with moving parts
d. Belt adjustment and condition
e. Fluid leaks
f. Lubricant levels
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Control system components
l. Pneumatic connections and tubing (No crimping)
m. As built configuration in accordance with design drawings
n. Fan, pump, compressor nameplate
o. Access for tests and maintenance

I-1500 Conditioning Equipment Inspection Checklist

a. Housing or duct interface with conditioning equipment
b. Belt and coupling guards
c. Interferences with moving parts
d. Belt tightness
e. Fluid leaks
f. Lubricant levels
g. Supports and attachments

h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Control system components
l. Pneumatic connections and tubing (No crimping)
m. Drains and spray nozzles not plugged
n. As built configuration in accordance with design drawings
o. Fan, pump, compressor nameplate
p. Access for tests and maintenance

I-1600 Moisture Separator Bank, Prefilter Bank, HEPA Filter Bank Inspection Checklist

a. Moisture separator media, frame, clamps and gaskets
b. Moisture separator water collection system and drains
c. Prefilter media, frame, clamps and gaskets
d. HEPA filter media, frame, clamps and gaskets
e. Sealant or caulking (none allowed)
f. Moisture separator, prefilter, HEPA orientation (vertical)
g. Bolting and fasteners.
h. As built configuration in accordance with design drawings
i. HEPA filter nameplate
j. Access for tests and maintenance

I-1700 Type II, Type III Adsorber Bank Inspection Checklist

a. Type II media, frame, screen, clamps and gaskets
b. Sealant or caulking (none allowed)
c. Type III media, screens, frame
d. Test canisters
e. Bulk loading equipment
f. Fire protection system piping, nozzles, instrumentation
g. Bolting and fasteners
h. As built configuration in accordance with design drawings
i. Adsorber nameplate
j. Access for tests and maintenance

APPENDIX TA-II
MANDATORY
STRUCTURAL CAPABILITY TEST PROCEDURE

II-1000 General

This procedure is used to test the structural capability of ducts and housings.

II-1100 Summary of Method

Ducts, and housings which form the pressure boundary of the system shall be pressure tested, with air, to the structural capability pressure to verify that there is no breach of integrity or unacceptable distortion. Fans, dampers and other components which form parts of the pressure boundary shall be installed and tested with the ducts and housings to verify the interface connection integrity.

NOTE: This test procedure is written as if the operating pressure were positive, but it would be identical for negative pressure systems with appropriate signs used in data collection and calculations.

II-2000 Prerequisites

Construction, modifications or repairs affecting the test boundary shall be complete and inlet and discharge openings of the duct or housing sealed before the test is started. Electrical, piping, and instrument connections shall be complete and all permanent seals installed before the test is started.

II-3000 Test Equipment

a. Pressurization source

b. Covers to seal test boundaries.

c. Pressure indicating device accurate to +/- 0.1 in.w.g. (0.025 kPa(gage)).

II-4000 Procedure

a. Connect the pressurization source to the duct or housing.

b. Install instrumentation to indicate the pressure inside the duct or housing being tested.

c. Start the pressurization source and operate until the structural capability pressure is achieved. Maintain pressure for the duration of the inspection.

d. Inspect the test boundary for breach of integrity or distortion.

e. Release pressure and inspect for permanent distortion.

II-5000 Acceptance Criteria

All distortion shall be measured and compared to the acceptance limits of the Owner's Design Specification.

APPENDIX TA-III
MANDATORY
DUCT AND HOUSING LEAK TEST PROCEDURE

III-1000 General

This procedure is used to test the leak tightness of the ducts and housings including installed fan housings, damper housings and fan and damper shaft seals.

III-1100 Summary of Method

Ducts and housings that form the pressure boundary of the system shall be leak tested, with air, using one of the methods listed in this procedure. Either method may be used and will produce a similar test result. The constant pressure method is useful for testing small volumes and is conducted at the maximum operating pressure for the system. The pressure decay method is useful in testing large volumes and is conducted by pressurizing to 1.25 times the maximum operating pressure, then allowing the pressure to decay for a fixed period of time, or until the pressure decreases to 80% of the maximum operating pressure, whichever occurs first. Fans, dampers, and other components that are part of the pressure boundary shall be installed and tested with the pressure boundary to verify interface connection leak tightness. If the measured leak rate is in excess of the acceptance criteria, the leaks shall be located by one of the methods listed in this procedure. After leaks are repaired, the duct and housing shall be re-tested to verify leak tightness.

NOTE: This test procedure is written as if the operating pressure were positive, but it would be identical for negative pressure systems with appropriate change in signs used in the data collection and calculations.

III-2000 Prerequisites

Construction, modifications and repairs affecting the test boundary shall be complete and the inlet and discharge openings of the duct or housing sealed before the test is started. All electrical, piping, and instrument connections shall be complete and all permanent seals shall be installed before the test is started. For pressure decay testing, the volume of the pressure test boundary must be calculated.

III-3000 Test Equipment

a. Pressurization source

b. Covers to seal test boundaries.

c. Clock or timer accurate to +/- 1.0 second.

d. Pressure indicating device accurate to +/- 0.1 in.w.g. (0.025 kPa(gage)).

e. Flowmeter or Totalizing Gas Volume meter accurate to +/-5% (constant pressure method).

f. Temperature indicating device accurate to +/- 0.5 °F (0.25°C).

g. Bubble solution for detecting air leaks (bubble method).

h. Optional portable electronic sound detection equipment (audible leak method).

i. Barometer

III-4000 **Procedure**

III-4100 **Constant Pressure Test**

a. Connect the pressurization source to the duct or housing.

b. Connect the flowmeter or totalizing gas volume meter between the pressurization source and the housing (downstream of the throttling valve, if used).

c. Install temperature and pressure indicating devices so that they will indicate representative temperature and pressure inside the duct or housing being tested.

d. Seal test boundaries and close access doors in the normal manner. Do not use temporary sealants, duct tape, or similar temporary materials except for sealing the temporary blank-off panels.

e. Start the pressurization source and operate it until the maximum operating pressure is achieved. Maintain pressure constant with the flow control device until temperature remains constant within +/- 0.5 °F (0.25 °C) for a minimum of 10 minutes. Record the initial stabilized pressure, temperature, and barometric pressure.

f. Measure the flow rate of the air being added to or removed from the duct or housing while maintaining the maximum operating pressure within +/- 0.1 in. w. g. (0.025 kPa(gage)). When using the flow meter, record flow readings once a minute for a 5 minute continuous period and average the readings to calculate the measured leak rate. When using a totalizing gas volume meter, measure the total volume of air for a 10 minute continuous period and divide the measured volume by time (10 minutes) to calculate the measured leak rate. Record final pressure, temperature and barometric pressure.

g. Convert the final calculated leak rate to standard cubic feet per minute (cubic meters per second) in accordance with the method illustrated in "Industrial Ventilation" (ref. TA-2000).

III-4200 **Pressure Decay Test**

a. Connect the pressurization source (with a leak tight shutoff valve) to the duct or housing.

b. Install the temperature and pressure indicating devices where they will indicate representative temperature and pressure inside the duct or housing being tested.

c. Seal test boundaries and close access doors in the normal manner. Do not use temporary sealants, duct tape, or similar temporary materials except for sealing the temporary blank-off panels.

d. Start the pressurization source and operate until the pressure is 1.25 times the maximum operating pressure (but not to exceed the structural capability pressure). Maintain this pressure constant with a flow control device until temperature remains constant within +/- 0.5 °F (0.25 °C) for a minimum of 10 minutes. Close shutoff valve.

NOTE(1): If the structural capability pressure for the duct or housing is less than 1.25 times the maximum operating pressure, the final test pressure shall be calculated as follows to achieve an average test pressure equal to the maximum operating pressure:

$$Pf = 0.8(OP_{max}) + (1.25(OP_{max}) - SCP)$$

where: Pf = final test pressure
OP_{max} = maximum operating pressure
SCP = structural capability pressure

e. Record the initial time, pressure, temperature, and barometric pressure.

f. Record pressure readings once a minute until pressure decays to 80% of the maximum operating pressure, or for a minimum of 15 minutes (see NOTE(1) in step d above).

h. Record final time, pressure, temperature, and barometric pressure.

i. Calculate leak rate from the following equation in English Units:

$$Q_{ave} = \left(\frac{Pi}{Ti} - \frac{Pf}{Tf} \right) * \frac{V}{R * \Delta t * 0.075}$$

Metric Units:

$$Q_{ave} = (1.39 * 10^{-5}) * \left(\frac{Pi}{Ti} - \frac{Pf}{Tf} \right) * \frac{V}{R * \Delta t}$$

where:
Q_{ave}= Average leak rate, scfm (sm^3/s). (air density 0.075 lb/ft3)
V = Volume within test boundary, ft^3 (m^3).

P_i = Initial pressure within test boundary, lb/ft^2 ABS (Pa(absolute)).
P_f = Final pressure within test boundary, lb/ft^2 ABS (Pa(absolute).

T_i = Absolute Temperature at start of test, °R (°K).
T_f = Absolute Temperature at end of test, °R (°K).
Δt = $t_i - t_f$ Time difference (minutes).
t_i = Time at start of test (minutes).
t_f = Time at end of test (minutes).
R = Gas Constant for Air; 53.35 $\frac{ft\text{-}lb}{lb\text{-}°R}$, (0.286 $\frac{kJ}{kg\text{-}°K}$)

III-4300 Acceptance Criteria

If the calculated leak rate exceeds the Owner's acceptance criteria, locate leaks in accordance with one of the techniques outlined in III-4400 or III-4500.

III-4400 Bubble Leak Location Method

a. Pressurize the test boundary to the maximum operating pressure for the system.

b. With the test boundary under continuous pressure, apply bubble solution to areas to be tested. Identify places where bubbles are found and perform corrective actions.

c. Following corrective actions, retest in accordance with III-4100 or III-4200.

III-4500 Audible Leak Location Method

a. Pressurize the test boundary to the maximum operating pressure for the system.

b. With the test boundary continuously pressurized, locate audible leaks (electronic sound detection equipment optional) and perform corrective actions.

c. Following corrective action, retest in accordance with III-4100 or III-4200.

APPENDIX TA-IV
MANDATORY
AIRFLOW DISTRIBUTION TEST PROCEDURE

IV-1000 General

This procedure is used to measure the air flow distribution across the face of moisture separator, prefilter, HEPA filter, and adsorber banks. Uniform air velocity distribution ensures maximum air treatment efficiency and uniform loading of air treatment components.

IV-1100 Summary of Method

The system is operated at design flow rate. Airflow velocity readings are measured downstream of each moisture separator, prefilter, and HEPA filter in the bank. For adsorbers, readings shall be taken in line with the flow slots. Each reading is compared to the average for the bank.

IV-2000 Prerequisites

System operating within +/- 10% design flow rate.

IV-3000 Test Equipment

Rotating vane, heated wire or heated thermocouple anemometer, pitot tube, or other suitable air velocity measuring device as appropriate for the anticipated velocities.

IV-4000 Procedure

a. For each moisture separator, prefilter, and HEPA filter, measure the air velocity at the approximate centers of equal areas with at least one measurement per each moisture separator, prefilter and HEPA filter, and a minimum of 9 measurements per bank. Adsorber velocity measurements shall be made in the approximate center of the flow slots. For flow slots greater than 24 inches long (60 cm), measurements shall be nominally every 12 inches (30 cm) along the length of the slot.

b. Calculate the average velocity (V_{ave}) using the following formula:

$$V_{ave}=\frac{\sum_1^n V_i}{n}$$

where:

$\sum_1^n$ = sum of readings from 1 to n

V_i = individual velocity readings
n = number of readings

c. Identify the highest and lowest velocity readings and calculate the percentage they vary from the average calculated above.

APPENDIX TA-V MANDATORY AIR-AEROSOL MIXING TEST PROCEDURE

V-1000 General

This procedure is used to ensure that the challenge aerosol or gas injection ports, used for the in-place leak tests of mandatory Appendix TA-VI and TA-VII, provide a uniform challenge across the entire face of the HEPA filter or adsorber banks. Uniform air-aerosol mixing ensures that all areas of the bank are challenged during these in-place tests. Once an injection port is qualified by this procedure, it shall be used in all subsequent in-place leak tests as outlined in the acceptance tests of TA-4600 and TA-4700.

V-1100 System Test

Injection and sample port location shall be located so that the entire system is challenged for inadvertent bypass flow paths around the HEPA filter or adsorber banks. If this cannot be accomplished, an integrated system test shall be included in addition to the bank tests outlined in appendix TA-VI, TA-VII and TA-4940.

V-1200 Summary of Method

The system is operated at design flow rate. Challenge aerosol or gas is injected through an injection port upstream of the bank. Challenge aerosol or gas concentration readings are obtained at equal cross-sectional areas in front of the HEPA filter or adsorber bank. Each reading is then compared to the average for the bank. DOP aerosol is the preferred challenge agent for this test. However, use of a challenge gas may be useful in some cases.

V-1300 Injection Port Selection Criteria

Injection ports should be located upstream of a flow disturbance to maximize mixing. The challenge gas will pass through the HEPA bank and challenge the adsorber bank. For systems with two or more HEPA filter banks in series, or two or more adsorber banks in series, separate injection ports must be qualified for each bank. Use of injection manifolds may be necessary when there is insufficient room between banks to provide adequate mixing.

V-2000 Prerequisites

The system is operating within +/- 10% of design flow rate. The airflow distribution has been verified in accordance with Appendix TA-IV.

V-3000 Test Equipment

a. Challenge aerosol or gas generator.

b. Challenge aerosol or gas measuring instrument.

V-4000 **Procedure**

a. Connect challenge aerosol or gas generator to the injection port to be tested.

b. Place the challenge aerosol or gas measuring instrument sample probe upstream of the bank to be tested with adequate hose length to reach all areas of the bank.

c. Start the challenge aerosol or gas injection and establish a constant injection rate.

d. Take a concentration reading upstream of and at the approximate centers of equal areas, with at least one reading per HEPA filter and a minimum of 9 readings per HEPA bank. For type II and type III adsorbers, readings shall be taken upstream of and in the approximate center of each flow slot. For flow slots greater than 24 inches (60 cm) in length, a reading shall be taken nominally every 12 inches (30 cm) along the length of the slot.

e. Calculate the average concentration (C_{ave}) readings using the following formula;

$$C_{ave} = \frac{\sum_1^n C_i}{n}$$

where:

$\sum_1^n$ = sum of readings from 1 to n

C_i = individual readings.
n = number of readings.

f. Identify the highest and lowest concentration readings and calculate the percentage it varies from the average above.

APPENDIX TA-VI
MANDATORY
HEPA FILTER BANK IN-PLACE LEAK TEST PROCEDURE

VI-1000 General

This procedure is used to leak test HEPA banks.

VI-1100 Summary of Method

The system is operated at design flow rate. Challenge aerosol is injected upstream of each bank through injection ports qualified in Appendix TA-V. The concentration of the challenge aerosol is measured upstream and downstream of the HEPA bank. The ratio of the downstream and upstream concentrations represents the HEPA filter bank leak rate.

VI-2000 Prerequisites

Airflow distribution shall be verified in accordance with Appendix TA-IV. The injection port shall be qualified to provide uniform air-aerosol mixing in accordance with Appendix TA-V.

VI-3000 Test Equipment

a. Challenge aerosol generator.

b. Challenge aerosol measuring instrument.

c. Flow measuring device.

VI-4000 Procedure

a. Connect challenge aerosol generator to the qualified injection port.

b. Place the challenge aerosol measuring instrument sample probes upstream and downstream of the bank to be tested. The sample tubing shall be of equal bore and approximately equal lengths and as short as possible to minimize the measuring instrument response time. The upstream sample probe shall be located in approximately the center of the bank. The downstream sample probe shall be located in a downstream sample manifold or downstream of a mixing source such as a turbulent fan discharge.

c. Start the system and verify stable flow rate within +/-10% of design flow rate.

d. Measure the upstream and downstream aerosol background concentration. The pre-injection background levels shall be stable to ensure correct instrument response and shall not interfere with the detector's ability to detect leaks in excess of the maximum allowed by the acceptance criteria.

e. Start the challenge aerosol injection.

f. Record the upstream and downstream concentrations. Repeat until at least three of the readings are stable.

g. Stop the injection.

h. Using the final set of readings meeting the stability and tolerance criteria, calculate the bank leak rate using the formula below:

$$L = (100)\frac{C_d}{C_u}$$

L = % Leak
C_d = Downstream concentration
C_u = Upstream concentration

APPENDIX TA-VII
MANDATORY
ADSORBER BANK IN-PLACE LEAK TEST PROCEDURE

VII-1000 General

This procedure is used to leak test adsorber banks.

VII-1100 Summary of Method

The system is operated at design flow rate. Challenge gas is injected upstream of each bank through the injection port qualified in Appendix TA-V. The concentration of challenge gas is measured upstream and downstream of the bank. The ratio of the downstream and upstream concentrations represents the bank leak rate.

VII-2000 Prerequisites

Airflow distribution shall be verified in accordance with Appendix TA-IV. The injection port shall be qualified to provide uniform air-aerosol mixing in accordance with Appendix TA-V.

VII-3000 Test Equipment

a. Challenge gas generator.

b. Challenge gas measuring instrument.

c. Flow measuring device.

VII-4000 Procedure

a. Connect challenge gas generator to the qualified injection port.

b. Place the challenge gas measuring instrument sample probes upstream and downstream of the bank to be tested. The sample tubing shall be of equal bore and approximately equal lengths and as short as possible to minimize the measuring instrument response time. The upstream sample probe shall be located in approximately the center of the bank. The downstream sample probe shall be located in a downstream sample manifold or downstream of a mixing source such as a turbulent fan discharge.

c. Start the system and verify stable flow rate and within +/-10% of design flow rate.

d. Measure the upstream and downstream challenge gas background concentration. The pre-injection background levels shall be stable to ensure correct instrument response and shall not interfere with the detector's ability to detect challenge gas leaks less than the maximum allowed by the acceptance criteria.

e. Start the challenge gas injection.

f. Record the upstream and downstream concentrations, as rapidly as instrument response time allows, until sufficient data have been recorded to allow calculation of adsorber bank leak rate. Care must be taken to obtain sufficient readings quickly after injection.

g. Terminate challenge gas injection.

h. Using the upstream and downstream concentration data, calculate the adsorber bank leak rate using the formula below.

$$L = (100) \frac{C_d}{C_u}$$

L = % Leak
C_d = Downstream concentration
C_u = Upstream concentration

APPENDIX TA-VIII
MANDATORY
REFRIGERANT PIPING AND COIL SYSTEM LEAK TEST PROCEDURE

VIII-1000 General

This procedure is used to test the leak tightness of refrigerant system piping and coils. The system will be pressurized with a test mixture to identify any leaks. After all identified leaks are repaired a vacuum will be drawn on the system to prove that there are no remaining leaks and to remove any contaminants from the system.

VIII-1100 Summary of Method

The pressure method consists of admitting a test gas, which is usually a mixture of refrigerant and inert gas, into the pressure vessel, coils and piping system and checking for leaks. The vacuum method consists of drawing a vacuum in the closed system and watching for a rise in pressure on a pressure indicator.

VIII-2000 Prerequisites

a. All flare, flange, solder, braze, weld or thread fittings mechanically tight.

b. All seals, packing glands and service valve packing nuts mechanically tight.

c. All service, purge and charging valves closed to the atmosphere.

d. Wire brush and wipe flux and oxides from all heated joints.

VIII-3000 Test Equipment

a. Refrigerant gas.

b. Inert gas (Nitrogen or carbon dioxide).

c. Pressure indicating device.

d. Pressure regulating device with relief valve.

e. Electronic refrigerant leak detector.

f. Leak detection bubble solution.

g. Vacuum Pump.

h. Vacuum indicating device (thermocouple vacuum indicator or other suitable vacuum indicating device).

VIII-4000 Procedure

VIII-4100 Leak Test Procedure

a. Open all interconnecting manual system valves, solenoid and expansion valves to ensure access to the complete system volume. CAUTION: Do not exceed the safe test pressure limits established by the unit manufacturer.

NOTE: It is advantageous and less costly to use an inert gas (Nitrogen or carbon dioxide), to back up the refrigerant vapor pressure. Only about 5 to 10% of the total mixture need be refrigerant vapor for this method to work.

b. Pressurize the entire system to the manufacturers recommended test pressure with the test mixture.

NOTE: Allow time for the refrigerant and inert gas to mix before checking for leaks.

c. Leak test the entire system, including factory joints, seals, and insulated lines with an electronic leak detector. Usually a one inch (2.5 cm) per second movement of the detector probe is sufficient to pick up leaks. Soap solution may also be used to locate leaks.

d. Mark or identify any leaks located.

CAUTION: Use appropriate reclaim equipment to prevent release of refrigerant gas to the atmosphere.

e. Leak testing is complete when all leaks have been repaired and the system has been re-pressurized and retested to verify that there are no leaks.

VIII-4200 Evacuation and Dehydration Procedure

Evacuate and dehydrate after leak testing per step VIII-4100. Proper evacuation and dehydration prove system tightness, expel non-condensables, and assure a dry system before charging with refrigerant.

VIII-4210 Deep Vacuum Method

a. Vent all system pressure.

CAUTION: Use appropriate reclaim equipment to prevent release of refrigerant gas to the atmosphere.

b. Connect a temporary connection between the system high and low pressure sides. Connect the vacuum pump, vacuum indicator, and refrigerant cylinder to the system.

c. Open the vacuum pump suction and start the evacuation.

d. When the system reaches less than 500 micrometers (Hg) absolute, it is isolated from the vacuum pump.

e. When the system holds 500 micrometer (Hg) absolute for at least 15 minutes, with the vacuum source isolated, the system is free of moisture and leaks and the vacuum should be released by charging with refrigerant.

APPENDIX TA-A
NON-MANDATORY
MOUNTING FRAME PRESSURE LEAK TEST PROCEDURE

A-1000 General

This optional test is used to identify leaks through seal welds of the HEPA filter or adsorber mounting frames. The presence of these leaks may be evident when conducting the in-place leak tests on the HEPA filter and adsorber banks. A good visual verification per Appendix TA-I, steps I-1600 and I-1700, is usually adequate. This procedure is provided for use when the frame leaks need to be located.

A-1100 Summary of Method

Temporary blanks, with gaskets, are installed in place of the HEPA filters or adsorbers on the mounting frame in the system. The pressure boundary is then secured by blanking off upstream of the mounting frame in the housing or associated ducts. This modified pressure boundary is then pressurized using the techniques outlined in Appendix TA-III and any leaks in the mounting frame welded interface is detected using the techniques in Appendix TA-III, steps III-4400 or III-4500.

A-2000 Prerequisites

Construction, modifications, and repairs affecting the test boundary shall be completed and temporary blanks (with gaskets) installed on the gasket side of the mounting frame. The opening of the duct or housing upstream of the mounting frame shall be blanked off to form a modified pressure boundary.

A-3000 Test Equipment

a. Pressurization source.

b. Covers to seal test boundaries.

c. Pressure indicating device accurate to +/- 0.1 in. w.g. (0.025 kPa(gage)).

A-4000 Procedure

a. Connect the pressurization source to the duct or housing pressure boundary.

b. Install pressure indicating device so that it will indicate the pressure inside the duct or housing being tested.

c. Close access doors.

d. Start the fan and operate until the pressure is greater than or equal to the maximum operating differential pressure for the filter bank (not to exceed the structural capability pressure for the duct and housing assembly). Maintain pressure for the duration of the inspection.

e. Inspect the mounting frame welds and attachments for leaks using the methods outlined in Appendix TA-III, steps III-4400 or III-4500.

APPENDIX TA-B
NON-MANDATORY
CORRECTIVE ACTION GUIDANCE

Corrective action may consist of replacement, repair, modification, maintenance, or analysis to demonstrate that the equipment will fulfill its design function. A revised set of reference values, as described in TA-3200, should be established after the corrective action has been taken.

Results of a failed test should not be resolved simply by a successful repetition of the test. A successful repetition of the test should be preceded by corrective action.

If the cause of the test failure cannot be determined by inspection or analysis, corrective action may consist of re-calibration of test instruments and subsequent re-testing. If it is determined that the test failure is due to an equipment malfunction, instead of difficulties with the test equipment, or test procedure, the equipment should be declared unavailable for service until the specific cause has been determined and the condition corrected.

APPENDIX TA-C
NON-MANDATORY
CHALLENGE GAS SUBSTITUTE SELECTION CRITERIA

Alternative test agents (challenge gas) may be used to perform In-Place Leak Testing of Adsorbers, as required in Mandatory Appendix TA-VII, when their selection is based on meeting the following characteristics:

1. The test agent gives the same In-Place Leak Test results as one of the following: R-11, R-12, R-112 or R-112a.

2. The test agent has similar retention times on activated carbons, at the same concentration levels, as one of the following: R-11, R-12, R-112 or R-112a.

3. The test agent has similar lower detection limit sensitivity and precision in the concentration range of use as one of the following: R-11, R-12, R-112 or R-112a.

4. The test agent exhibits chemical and radiological stability under the test conditions.

5. The test agent causes no degradation of the carbon and its impregnant(s) or of the other Nuclear Air Treatment System components under the test conditions.

6. The test agent is listed in the Environmental Protection Agency "Toxic Substance Control Act" (TSCA) inventory for commercial use.

ASME N511-19XX

Standard for Periodic In-Service Testing of Nuclear Air Treatment, Heating, Ventilating and Air Conditioning Systems

For ASME AG-1 Systems

ASME Committee on Nuclear Air and Gas Treatment (CONAGT)

Note: This is a draft document. An approved standard may differ in many respects. This draft version is made available for discussion for discussion purposes only.

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DRAFT
PERIODIC IN-SERVICE TESTING OF NUCLEAR AIR TREATMENT, HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

TABLES

MANDATORY APPENDICES

NON-MANDATORY APPENDICES

IN-SERVICE TESTING OF NUCLEAR AIR TREATMENT, HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

1 SCOPE

This Standard covers the requirements for Periodic In-Service testing of nuclear safety-related air treatment, heating, ventilating, and air conditioning systems in nuclear facilities.

1.1 Purpose

The purpose of this Standard is to provide requirements for periodic in-service testing, the results of which are used to verify that nuclear air treatment, heating, ventilating, and air conditioning systems continue to perform their intended function. Such in-service testing is conducted for the purpose of:

(a) Monitoring the performance of the equipment and system(s) to provide assurance that they continue to function within their specified design basis limits;

b) Providing test results which are compared to Acceptance Test Reference Values and to previous in-service test results to establish system performance trends.

1.2 Applicability

This Standard applies to periodic in-service testing of nuclear safety-related air treatment, heating, ventilating, and air conditioning systems which have been designed, built, and acceptance tested in accordance with ASME AG-1. Sections of this Standard may be used for technical guidance for testing air treatment, heating , ventilating, and air conditioning systems designed to other standards. It is the Owner's responsibility to meet each of the applicable requirements in this Standard.

1.3 Use of This Standard

This Standard provides a basis for the development of test programs and does not include acceptance criteria, except where the results of one test influence the performance of other tests. Acceptance criteria shall be developed by the Owner based on the system design and function(s) in accordance with ASME AG-1.

This Standard is arranged so that users may select those portions (tests) which are relevant to their facility. The users must specify which tests shall be employed in their test programs and the acceptance criteria for those tests. The Non-Mandatory Appendices provide additional information and guidance.

1.4 Terms and Definitions

The definitions provided in this section supplement those listed in ASME AG-1 Section AA-1000.

Abnormal Incident -- any event or condition which may adversely affect the function of the nuclear air treatment, heating, ventilating, and air conditioning system.

Acceptance Test -- a test to verify system or component design function following initial field installation, abnormal incident, replacement, repair, or modification, that may affect a test reference value.

Adsorbent -- a solid having the ability to concentrate other substances on its surface.

Adsorber -- a device or vessel containing adsorbent.

Adsorber Bank or *Filter Bank* -- one or more filters or adsorbers secured in a single mounting frame, or one or more side by side panels containing poured or packed air treatment media, confined within the perimeter of a duct, plenum, or vault cross section, sometimes referred to as a stage.

Aerosol -- a stable suspension of particles, solid or liquid, in air

Challenge -- to expose a filter, adsorber, or other air treatment device to an aerosol or gas of known characteristics, under specified conditions, for the purpose of testing.

Challenge Gas -- a gas of known characteristics, under specified conditions, used for the purpose of testing. For in-place testing of adsorbers, the challenge gas is Refrigerant-11, or an acceptable substitute. (Refer to Non-Mandatory Appendix C for alternate challenge gas selection criteria)

Challenge Aerosol -- poly-disperse droplets of dioctyl phthalate, (di(2-ethyl hexyl) phthalate), used as challenge aerosol for testing HEPA filter banks for leaks. The challenge aerosol used for in-place leak testing of installed HEPA filter systems, in accordance with this section, shall be a poly-disperse liquid aerosol having an approximate light scattering droplet size distribution as follows:

99% less than 3.0 micrometer diameter
50% less than 0.7 micrometer diameter
10% less than 0.4 micrometer diameter

NOTE: The poly-disperse aerosol used for in-place leak testing of systems differs in size from the 0.3 micrometer mono-disperse DOP aerosol used for efficiency testing of individual HEPA filters by manufacturers. For potential substitutes for DOP, reference ASME AG-1 paragraph TA-2000. (reference DOE Nuclear Air Cleaning Conference proceedings "Size Distribution of Aerosols Produced From Substitute Materials by Laskin Cold DOP Aerosol Generator")

HEPA Filter -- (High Efficiency Particulate Air) a disposable, extended media, dry type filter enclosed in a rigid casing, that has a minimum efficiency of 99.97% when tested with an essentially mono-disperse 0.3 micrometer test aerosol.

In-Service Test -- a periodic test to verify that a system or component meets its intended design function.

Pressure, Maximum Operating -- The maximum pressure the system components will be subjected to while performing their function. The allowable pressure during abnormal operating conditions which will not physically damage the system (e.g. sudden closure of dampers or registers), shall be considered maximum operating pressure.

Pressure, Operating -- the pressure that corresponds to the normal design operating mode of the system. This pressure is less than or equal to the maximum operating pressure.

Pressure, Structural Capability -- the pressure to which the designer specifies the component or system can be safely operated, including transient conditions, without permanent distortion.

Reference Value -- one or more achieved values or test parameters that are measured, observed, or determined when the equipment or system is known to be operating acceptably within its design basis limits.

System -- An assembly of components, including associated instruments and controls, required to perform the safety-related function of a nuclear air treatment, heating, ventilating, and air conditioning system.

Test Boundary -- the physical limits of the component, system, or device being subjected to a specified test.

Test Canister -- a specially designed sample holder containing adsorbent for laboratory tests which can be removed from an adsorber bank, without disturbing the remainder of the adsorber, to provide representative

DOE Proceedings 16th DOE Nuclear Air Cleaning Conference, page 125, "Size Distribution of Aerosols Produced from Substitute Materials by the Laskin Cold DOP Aerosol Generator", February 1981, NTIS Springfield, VA. (W. Hinds, J. Macher, M. First).

3 GENERAL INSPECTION AND TEST REQUIREMENTS

All inspections and tests shall be conducted in accordance with these requirements and the specific requirements of Sections 6 and 8.

NOTE: Activities in this Section may involve the use of hazardous materials, operations and equipment. This Section does not purport to address all of the safety requirements associated with their use. It is the responsibility of the user of this Section to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.

3.1 TEST INSTRUMENTS

A calibration program shall be established in accordance with the Owner's Quality Assurance Program. All permanent and temporary test instruments used in the conduct of tests required by this Standard shall be in calibration. Instrument accuracy shall meet or exceed the requirements of Table 3-1.

TABLE 3-1
INSTRUMENT ACCURACY REQUIREMENTS

MEASUREMENT	RANGE	ACCURACY
Pressure	>1.0 psig (>7.0 kPa(gage))	+/- 2.0 %
Pressure	from 1.0 in wg to 1.0 psig (0.25 to 7.0 kPa(gage))	+/- 0.1 in wg (+/-0.025 kPa)
Pressure	from 0.1 in wg to 1.0 in wg (25 to 250 Pa(gage))	+/- 0.01 in wg (+/-2.5 Pa)
Temperature	variable	+/- 2.0 °F (+/- 1.0 °C)
Temperature*	variable	+/- 0.5 °F (+/- 0.25 °C)
Vibration	variable	(per para. 3.1.4.1)
Flow	variable	+/- 5.0 %
Velocity (airflow)	variable	+/- 3.0 %
Speed	variable	+/- 2.0 %
Time	variable	+/- 1.0 sec
Electrical voltage	variable	+/- 1.0 %
Electrical resistance	variable	+/- 1.0 %
Challenge aerosol concentration		(per para. 3.1.4.2)
Challenge gas concentration		(per para. 3.1.4.3)

* Required for pressure testing in Mandatory Appendix II.

samples for laboratory testing.

2 Reference Documents

The following documents supplement this Standard and are a part of it to the extent indicated in the text. The issue of the referenced document noted below shall be in effect. If no date is listed, then the issue of the referenced document in effect at the time shall apply.

2.1 AMERICAN CONFERENCE OF GOVERNMENT INDUSTRIAL HYGIENISTS (ACGIH)

INDUSTRIAL VENTILATION: A Manual of Recommended Practice.

2.2 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3803-1989, Standard Test Method for Nuclear Grade Activated Carbon.

2.3 AMERICAN NUCLEAR SOCIETY (ANS)

ANS 3.1 , Selection Qualification and Training of Nuclear Power Plant Personnel. (latest edition)

2.4 American Society of Mechanical Engineers (ASME)

ASME AG-1-1994, Code On Nuclear Air And Gas Treatment

ANSI/ASME NQA-1-1989, Quality Assurance Program Requirements for Nuclear Facilities.

ASME N509-1989, Nuclear Power Plant Air Cleaning Units and Components

ASME N510-1989, Testing of Nuclear Air Treatment Systems

2.5 SHEET METAL AND AIR-CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC (SMACNA)

HVAC Systems Testing, Adjusting, and Balancing 1983.

2.6 ASSOCIATED AIR BALANCE COUNCIL (AABC)

National Standard of Total System Balance 1989.

2.7 NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems 1991.

2.8 DEPARTMENT OF ENERGY,(DOE)

3.1.1 **Range Requirements**

The full scale range of instruments shall be limited as necessary to ensure that the readings are within the accuracy requirements of Table 3-1.

3.1.2 **Instrument Fluctuation**

Symmetrical damping devices or averaging techniques may be used to reduce random signal fluctuations. Hydraulic instruments may be damped by using gauge snubbers or by throttling valves in instrument lines.

3.1.3 **Evaluation Following Test Instrument Loss, Damage or Calibration Failure**

When a test instrument is lost, damaged, or otherwise fails to meet the requirements of Table 3-1 during calibration, all test results obtained using the instrument shall be evaluated, dating back to the time of the previous calibration. If the evaluation does not confirm that the instrument met the acceptance criteria for the test(s) in question, the test(s) shall be repeated with calibrated instruments.

3.1.4 **Specific Instrument Accuracy Requirements**

3.1.4.1 **Vibration Instrument**

Vibration instrument accuracy shall be at least +/- 10%. The minimum frequency response range of the vibration measuring instrument shall be approximately one third of the minimum shaft speed. For rotating components, the maximum frequency response range shall be at least two times the rotational shaft speed of the component being measured. For reciprocating components, the maximum frequency response range shall be at least two times the speed of the crankshaft, times the number of unique planes occupied by a piston throw.

3.1.4.2 **Challenge Aerosol Measuring Instrument**

The Challenge Aerosol Measuring Instrument shall be verified to have a linear range of at least 10^5 times the minimum detectible quantity of the instrument with an accuracy in accordance with the Facility Project Specifications and Owner's Quality Assurance Program.

3.1.4.3 **Challenge Gas Measuring Instrument**

The Challenge Gas Measuring Instrument shall be verified to be capable of distinguishing challenge gas from background and measuring challenge gas over a linear range of at least 10^5 times the minimum detectible quantity of the instrument with an accuracy in accordance with the Facility Project Specifications and Owner's Quality Assurance Program.

4 REFERENCE VALUES

4.1 Establishment of Reference Values

Reference values are determined during acceptance testing (ASME AG-1 Section TA-4000), when the equipment or system is proven to be operating within the acceptable limits of the Owner's Design Specification. Operating tests and inspections specified in ASME AG-1 Section TA-4000 are performed under conditions readily reproducible during subsequent in-service tests to allow for direct comparison of test results. All test results and associated analyses are included in the test procedure documentation.

4.2 Re-establishment of Reference Values Following Component Replacement, Repair, or Modification

Following component replacement, repair, or modification requiring disassembly, an analysis shall be conducted to determine the effect on current reference values. Whenever the analysis indicates any of the reference values have been affected, new reference values shall be established in accordance with paragraph 4.1 or the previous reference values re-verified. Analysis of the new reference values shall verify that the component conforms to acceptance criteria prior to accepting it as fully operational. The analysis to determine the effect on reference values shall be documented.

5 INSPECTIONS AND TEST REQUIREMENTS

Equipment shall be evaluated as separate components and as functioning parts of an integrated system. The Owner shall define system test boundaries and evaluate system performance with respect to system functional requirement in accordance with the Owners Design Specifications. The following categories of tests shall be implemented as applicable and in accordance with this Section.

(a) Periodic in-service tests (Section 8).
(b) Tests following an abnormal incident (Section 9).
(c) Tests following component replacement, repair, modification or maintenance (paragraph 4.2).

Test designations associated with tests required by this Standard are listed in Table 3-2.

TABLE 3-2
TEST DESIGNATIONS

TEST	DESIGNATOR
Differential pressure test	DP
Differential temperature test	DT
Flow rate test	Qf
Functional test*	F
In-place leak test	IP
Laboratory analysis (adsorbent methyl-iodide penetration)	LAB
Electrical performance test	AMP
Leak test	PL
Rotational speed test	N
Bearing temperature test	Tb
Vibration test	Vb
Visual inspection	VT
Flow Distribution Test	Qf

* Functional tests consist of various mechanical actuation and performance verifications and are detailed separately in each test section.

5.1 **Inspection and Test Parameters**

Parameters which need to be observed, calculated and recorded in order to meet the requirements of this Section shall be identified for each system based upon the functional requirements of the Owner's Design Specification.

5.2 **System Operating Conditions**

Operating conditions required for in-service testing shall be determined for each system. These conditions and acceptance criteria shall be based upon the requirements of the Owner's Design Specification.

5.3 **Procedure Requirements**

The Owner shall be responsible for the development and implementation of written test procedures that meet the requirements of this Standard. Each equipment test Section consists of generic (Section 7) and specific (Section 8) test requirements and acceptance criteria which apply to each of the systems in the facility. The Owner shall document which requirements are applicable.

5.4 **In-Service Tests**

In-service tests shall be conducted at intervals not to exceed those specified in Section 8 or the Owners Design Specification, whichever is most limiting. When a test is not practical during facility operation or cannot be conducted due to excessive personnel hazard, the justification for postponement shall be documented and the test shall be completed after entering a condition in which the test can be conducted. When the in-service test interval expires during a period in which the component or system is not required for standby or normal operation, the test shall be conducted prior to returning equipment to normal operation. In-service test intervals are defined in Table 3-3.

TABLE 3-3
IN-SERVICE TEST INTERVALS

INTERVAL	TEST FREQUENCY	SYMBOL
Monthly	Once per 31 days	M
Quarterly	Once per 92 days	Q
Yearly	Once per 366 days	Y

6 GENERIC TESTS

Generic tests as specified in Sections 6.1 through 6.3 shall also be used in Section 8 where applicable.

6.1 Visual Inspection (VT)

Visual inspections shall be conducted in accordance with ASME AG-1 Section AA-5000 and the applicable portions of Mandatory Appendix I. The periodic in-service visual inspections listed in Section 8 shall verify that no unacceptable damage or degradation, which could impair function, has occurred to the equipment or system since the last inspection.

6.2 Pressure Boundary Tests

Pressure boundary tests consist of leak tests for ducts and housings, including fan and damper housings.

6.2.1 Leak tests for duct and housing sections shall be conducted using either the pressure decay method or the constant pressure method to verify that the leak rate for the duct or housing does not exceed the allowable limits established for the system. Testing shall be conducted in accordance with Mandatory Appendix II. Leak testing performed to satisfy ASME AG-1 Section SA may be used to meet these test requirements when the test method is compatible with Mandatory Appendix II.

An optional leak test for HEPA filter and adsorber mounting frames may be conducted, in conjunction with the housing leak test, by blanking off the frame openings and pressurizing the isolated test boundary. This procedure is useful for detecting small leaks in the mounting frame following repair or modification of a mounting frame or mounting frame interface. This test is used to verify that there are no defects in a frame that may cause failure of the in-place leak test. Testing shall be conducted in accordance with Non-Mandatory Appendix A.

6.3 Vibration Test (Vb)

Vibration measurements shall be taken on the accessible motor, fan, compressor and pump bearing housings in at least two different orthogonal planes approximately perpendicular to the line of the rotating shaft. When the bearing housing is not accessible, the frame of the component may be used if it will be representative of bearing housing vibration. When portable vibration instruments are used, reference points shall be clearly identified on the component being measured to permit duplication in both location and plane.

7 ACCEPTANCE CRITERIA

Results of tests described in Section 8 shall be subject to the acceptance criteria in Section 7 and to the applicable operating and design criteria specified by the Owner's Design Specification. Test results are considered acceptable if the component or system is not impaired or degraded to the point that it cannot perform its intended function. Acceptance criteria are specified in Section 8 only when they affect the quality of other tests. When test results do not meet the applicable acceptance criteria, the corrective actions required by Section 10 shall be initiated. In-service test results shall be compared to the acceptance test reference values and previous in-service test results. Comparison shall include a trend analysis designed to predict degradation rates of the components under test. Projected degradation rates that indicate probable loss of intended design function prior to the next scheduled in-service test shall require corrective action prior to the predicted loss of intended design function in accordance with Section 10.

7.1 Visual Inspection

Visual inspections are acceptable when there are no visual indications of improper installation, physical damage, structural distress or degradation that would impair the ability of the equipment or system to perform its intended function.

7.2 Pressure Boundary Tests

Pressure boundary tests are acceptable when there is no permanent structural deformation or leaks in excess of the limits specified in the applicable Sections of ASME AG-1 and the Owner's Design Specification.

7.3 Functional Tests

Functional tests are acceptable when they meet the requirements of the applicable Sections of ASME AG-1 and the Owner's Design Specification.

8 IN-SERVICE TEST REQUIREMENTS

8.1 General

In-service tests shall be conducted at the required time intervals after the completion of the field acceptance tests outlined in ASME AG-1 Article TA-4000. These tests shall be conducted at intervals not to exceed those stated in each Section of this Standard. When the in-service test interval is exceeded, the affected equipment shall be unavailable for service until the required in-service test can be successfully completed. In-service tests are not required to be maintained during periods when the equipment is not required to be available for operation as specified by the Owner's Design Specification. However, these in-service tests are required to be successfully completed prior to returning the equipment to normal or standby service.

8.2 FAN IN-SERVICE TESTS.

This Section provides the in-service test requirements for fans and related accessories. Integrated system testing shall be conducted in accordance with Section 8.10.

8.2.1 In-service Test Requirements

In-service tests listed in Table 8-1 shall be conducted at the specified interval and test results verified to be within the acceptance limits of the Owner's Design Specification and Section 7 and compared to the reference values obtained in acceptance tests in ASME AG-1 Article TA-4100.

TABLE 8-1
FAN IN-SERVICE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE	INTERVAL
Visual inspection	VT		*	Q
Leak test	PL	*		10Y
Mechanical run test	F		*	Q
Flow rate test	Qf	*		2Y
Static pressure test	DP	*		2Y
Rotational speed test	N	*		2Y
Vibration test	Vb	*		Q

8.2.2 Visual Inspection (VT)

A visual inspection of the fan and associated components shall be conducted in accordance with Section 6.1 and Mandatory Appendix I (I-1100).

8.2.3 Pressure Boundary Test

8.2.3.1 Leak Test (PL)

When a fan housing is part of the system pressure boundary, a pressure boundary leak test shall be conducted to verify the leak tightness of the fan housing, shaft seal and attached interfaces in accordance with paragraph 6.2.1 and Mandatory Appendix II. The fan housing, shaft seal and attached interfaces may be tested concurrent with the duct and housing leak test specified in paragraph 8.4.3.1. However, the shaft seal leak rate shall be evaluated (qualitative) independently of the overall system leak rate.

8.2.4 System Functional Tests

Sections 8.2.4.1 through 8.2.4.5 shall be conducted in the same time frame.

8.2.4.1 Mechanical Run Test (F)

The fan shall be operated at the design flow rate for at least 15 minutes and stable system operation (no surging) verified.

8.2.4.2 Flow Rate Test (Qf)

The fan flow rate shall be measured. Recommended procedures include "ACGIH Industrial Ventilation" or equivalent.

8.2.4.3 Static Pressure Test (DP)

The fan inlet and outlet static pressure and velocity pressure shall be measured and the overall fan static pressure determined.

8.2.4.4 Rotational Speed Test (N)

When a fan does not have a direct drive coupling to the motor, the rotational speed of the fan shaft shall be measured.

8.2.4.5 Vibration Test (Vb)

The vibration of each fan and motor bearing shall be measured in accordance with Section 6.3.

8.3 DAMPER IN-SERVICE TESTS

This Section provides the in-service test requirements for dampers and related accessories. Integrated system testing shall be conducted in accordance with Section 8.10.

8.3.1 In-service Test Requirements

In-service tests listed in Table 8-2 shall be conducted at the specified interval and test results verified to be within the acceptance limits of the Owner's Design Specification and Section 7, and be compared to the reference values obtained in the acceptance tests in ASME AG-1 Article TA-4200.

8.3.2 Visual Inspection (VT)

A visual inspection of the dampers and associated components shall be conducted in accordance with Section 6.1 and Mandatory Appendix I (I-1200).

8.3.3 Pressure Boundary Tests.

8.3.3.1. Leak Test, Damper Seat (PL)

When dampers have seat leak rate limits, a dynamic pressure boundary leak test shall be conducted in the direction the damper is expected to function, in accordance with paragraph 6.2.1 and Mandatory Appendix II. Seat leakage shall be tested by blanking off or otherwise isolating a duct Section upstream of the damper. The leak test shall be performed with the damper cycled closed using its normal closing mechanism (exclusive of any additional assistance).

TABLE 8-2
DAMPER IN-SERVICE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE	INTERVAL
Visual inspection	VT		*	2Y
Leak test	PL	*		2Y
Position indication test	F		*	2Y
Exercise test	F		*	2Y
Flow Control test	F		*	2Y
Static timing test	F	*		Q
Fire damper test	F		*	2Y
Dynamic time test	F	*		2Y
Interlock test	F		*	2Y

8.3.4 Component Functional Tests

Component functional tests shall verify that the damper is operational prior to conducting the system functional tests specified in Section 8.3.5.

8.3.4.1 Position Indication Test (F)

Dampers having remote position indicators shall be observed during operation to verify that the damper position corresponds to the remote indicator.

8.3.4.2 Exercise Test (F)

Power operated dampers shall be fully cycled using a control switch or other actuating device to verify operation. Manual dampers, which have a shut off function shall be fully cycled to verify operation. Fire dampers shall be tested in accordance with paragraph 8.3.5.2.

8.3.4.3 Static Timing Test (F)

Power operated dampers that are required to operate within a specified time limit shall be tested by measuring the time to fully open or fully close (as required by the Owners Design Specification).

8.3.5 System Functional Tests

8.3.5.1 Flow Control Test (F)

Power operated dampers that control airflow shall be observed under throttled flow conditions to verify freedom of movement and stable operation.

8.3.5.2 Fire Damper Test (F)

Fire dampers shall be tested, using a normal or simulated actuation signal, to verify activation under design flow.

8.3.5.3 Dynamic Timing Test (F)

Isolation dampers having a required actuation response time shall be timed to the fully open or fully closed position (as required by the Owners Design Specification) under design flow rate conditions.

8.3.5.4 Interlock Test (F)

Dampers that have an opening or closing function interlocked with other components, (e.g. fan, other dampers), shall be tested to verify interlock action.

8.4 DUCT AND HOUSING IN-SERVICE TESTS

This Section provides the in-service test requirements for ducts and housings.

8.4.1 In-service Test Requirements

In-service tests listed in Table 8-3 shall be conducted at the specified interval and test results verified to be within the acceptance limits of the Owner's Design Specification and Section 7. Test results shall be compared to the reference values obtained in the acceptance tests in ASME AG-1 Article TA-4300.

TABLE 8-3

DUCT AND HOUSING IN-SERVICE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE	INTERVAL
Visual inspection	VT		*	2Y*
Leak test	PL	*		10Y

* Loop seal water level in duct or housing drain lines shall be maintained to ensure the integrity of the system pressure boundary at all times. More frequent inspection of the water level in the loop seal may be required, depending on the system design.

8.4.2 Visual Inspection (VT)

A visual inspection of the ducts, housings, and associated attachments shall be conducted in accordance with Section 6.1 and Mandatory Appendix I (I-1300).

8.4.3 Pressure Boundary Tests

8.4.3.1 Leak Test (PL)

A pressure boundary leak test shall be conducted on filter housings in accordance with Section 6.2 and Mandatory Appendix II.

8.5 **REFRIGERATION EQUIPMENT IN-SERVICE TESTS**

This Section provides the in-service test requirements for refrigeration equipment. Integrated system testing shall be conducted in accordance with Section 8.10.

8.5.1 In-service Test Requirements

In-service tests listed in Table 8-4 shall be conducted at the specified interval and test results verified to be within the acceptance limits of the Owner's Design Specification and Section 7. Test results shall be compared to the reference values obtained in the acceptance tests in ASME AG-1 Article TA-4400.

TABLE 8-4
REFRIGERATION EQUIPMENT IN-SERVICE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE	INTERVAL
Visual inspection	VT		*	Q
Leak tests	VT	*		Q
Valve position indication test	F		*	2Y
Valve exercise test	F		*	2Y
Valve timing test	F	*		Q
Flow Control valve test	F		*	Q
Mechanical run test	F		*	Q
Performance test	F	*		Q
Vibration test	Vb	*		Q
Rotational Speed test	N	*		2Y

8.5.2 Visual Inspection (VT)

A visual inspection of the refrigeration equipment components shall be conducted in accordance with Section 6.1 and Mandatory Appendix I (I-1400).

8.5.3 Pressure Boundary Tests

8.5.3.1 Leak Test, Refrigerant Piping and Coils (VT)

With the refrigerant system under normal operating pressure, refrigerant fluid levels shall be monitored to verify no unacceptable refrigerant leaks.

8.5.3.2 Leak Test, Hydronic Piping and Coils (VT)

Hydronic piping and coils shall be observed to verify no unacceptable fluid leaks. Testing shall be conducted by inspecting the fluid system, under normal operating pressure, for evidence of leaks.

8.5.4 Component Functional Tests

Fans shall be tested in accordance with Section 8.2.

8.5.4.1 Valve Position Indication Test (F)

Valves with position indicators shall be observed during valve full stroke operation to verify that the valve position corresponds to the remote indication.

8.5.4.2 Valve Exercise Test (F)

Power operated valves shall be fully stroked using their remote control switch or other actuation device to verify operation. Manual valves shall be fully stroked to verify freedom of movement.

8.5.4.3 Valve Timing Test (F)

Power operated valves that are required to operate within a specified time limit shall be tested by measuring the stroke time.

8.5.5 System Functional Tests

8.5.5.1 Flow Control Valve Test (F)

Power operated valves, controlled by flow instrumentation, shall be observed under throttled flow conditions to verify freedom of movement and stable operation.

8.5.5.2 Mechanical Run Test (F)

The refrigeration compressor shall be operated with the system operating in the normal heat load range for at least 15 minutes and stable system operation verified.

8.5.5.3 Performance Test (F)

The refrigeration compressor inlet and outlet pressure and temperature shall be measured with the refrigeration equipment operating at achievable load points.

8.5.5.4 Vibration Test (Vb)

The vibration on each accessible bearing of the compressor and associated motor in the refrigeration system shall be measured in accordance with Section 6.3.

8.5.5.5 Rotational Speed Test (N)

For refrigerant compressors that have variable speed drives, or that do not otherwise have direct drive operations, the rotational speed of the compressor shaft shall be measured (not required for hermetically sealed compressors).

8.6 CONDITIONING EQUIPMENT IN-SERVICE TESTS

This Section provides the in-service test requirements for conditioning equipment. Integrated system testing shall be conducted in accordance with Section 8.10.

8.6.1 In-Service Test Requirements

In-service tests listed in Table 8-5 shall be conducted at the specified interval and test results verified to be within the acceptance limits of the Owner's Design Specification, Section 7 and compared to the reference values obtained in the acceptance tests in ASME AG-1 Article TA-4500.

TABLE 8-5
CONDITIONING EQUIPMENT IN-SERVICE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE	INTERVAL
Visual inspection	VT		*	Q
Leak test	VT	*		Q
Valve performance tests	F		*	2Y
Mechanical run test	F		*	Q
Performance test	F	*		2Y
Rotational speed test	N	*		2Y
Vibration test	Vb	*		Q
Elect heater performance test	AMP	*		2Y
Hydronic heating and cooling performance test	F	*		2Y

8.6.2 Visual Inspection (VT)

A visual inspection of the conditioning equipment components shall be conducted in accordance with Section 6.1 and Mandatory Appendix (I-1500).

8.6.3 Pressure Boundary Test

8.6.3.1 Leak Test, Hydronic Piping and Coils (VT)

With the conditioning system at normal operating pressure, hydronic piping, coils, and pressure vessels shall be observed to verify no unacceptable fluid leaks.

8.6.4 Component Functional Test

Fans shall be tested in accordance with Section 8.2. Refrigeration components shall be tested in accordance with Section 8.5.

8.6.4.1 Valve Performance Tests (F)

Conditioning system valves shall be tested in accordance with Sections 8.5.4.1, 8.5.4.2 and 8.5.4.3

8.6.5 System Functional Tests

8.6.5.1 Hydronic System Flow Balance Verification Test

A verification of the hydronic system flow balance shall be conducted. Recommended procedures include SMACNA, NEBB, AABC, or equivalent.

8.6.5.2 Flow Control Valve Test (F)

Power operated valves, controlled by flow instrumentation, shall be observed under throttled flow conditions to verify freedom of movement, stable operation, and ability to maintain the required flow rate.

8.6.5.3 Mechanical Run Test (F)

The conditioning system pumps shall be operated, at the reference flow rate, for at least 15 minutes and stable system operation verified.

8.6.5.4 Performance Test (F)

With the conditioning system pump operating at the reference flow rate, pump differential pressure and flow rate shall be measured.

8.6.5.5 Rotational Speed Test (N)

For conditioning system pumps that have variable speed drives, or that do not otherwise have direct drive operations, the rotational speed of the pump shaft shall be measured.

8.6.5.6 Vibration Test (Vb)

The vibration of each bearing on the pump and associated motor in the conditioning system shall be measured in accordance with Section 6.3.

8.6.5.7 Electric Heater Test (AMP)

With design flow rate through the heater bank, the electrical supply voltage, amperage, phase balance, and differential temperature shall be measured.

8.6.5.8 Hydronic Heating and Cooling Performance Test (F)

With the conditioning system operating at design air and hydronic flow rate, at the available heat load conditions, the air side flow, differential pressure and differential temperature, and the hydronic side flow, differential temperature and differential pressure shall be measured.

8.7 MOISTURE SEPARATOR, PREFILTER, HEPA FILTER BANK IN-SERVICE TESTS

This Section provides the in-service test requirements for installed moisture separator, pre-filter, and HEPA filter banks.

8.7.1 In-Service Test Requirements

In-service tests listed in Table 8-6 shall be conducted at the specified interval and test results verified to be within the acceptance limits of the Owner's Design Specification, Section 7 and compared to the reference values obtained in the acceptance tests in ASME AG-1 Article TA-4600.

TABLE 8-6
MOISTURE SEPARATOR, PREFILTER, HEPA FILTER BANK
IN-SERVICE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE	INTERVAL
Visual inspection	VT		*	2Y
Differential pressure test	DP	*		M
In-place leak test	IP		*	2Y*

*In-place leak tests are not required on systems used for 100% recirculation (e.g. Reactor containment cleanup units).

8.7.2 Visual Inspection (VT)

A visual inspection of the installed moisture separator, prefilter and HEPA filter banks shall be conducted in accordance with Section 6.1 and Mandatory Appendix I (I-1600).

8.7.3 System Functional Tests

8.7.3.1 Differential Pressure Test (DP)

With the system operating at design flow rate (+/- 10%), the differential pressure across each moisture separator, prefilter, and HEPA filter bank shall be measured.

8.7.3.2 In-Place Leak Test (IP)

With the system operating at design flow rate (+/- 10%), the challenge aerosol leak rate of each HEPA filter bank shall be measured in accordance with Mandatory Appendix IV.

8.8 TYPE II and TYPE III ADSORBER BANK IN-SERVICE TESTS

This Section provides the in-service test requirements for installed type II and type III adsorber banks.

8.8.1 In-service Test Requirements

In-service tests listed in Table 8-7 shall be conducted at the specified interval and verified to be within the acceptance limits of the Owner's Design Specification, Section 7, and compared to the reference values obtained in the acceptance tests in ASME AG-1 Article TA-4700.

TABLE 8-7
TYPE II, TYPE III ADSORBER BANK IN-SERVICE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE	INTERVAL
Visual inspection	VT		*	2Y
Differential pressure test	DP	*		M
In-place leak test*	IP	*		2Y
Electric Heater Performance Test	F	*		2Y

*In-place leak tests are not required on systems used for 100% recirculation (e.g. Reactor containment cleanup units).

8.8.2 Visual Inspection (VT)

A visual inspection of the type II and type III adsorber banks shall be conducted in accordance with Section 6.1 and Mandatory Appendix I (I-1700).

8.8.3 System Functional Tests

8.8.3.1 Differential Pressure Test (DP)

With the system operating at design flow rate (+/- 10%), the differential pressure across each adsorber bank shall be measured.

8.8.3.2 In-Place Leak Test (IP)

With the system operating at design flow rate (+/- 10%), the challenge gas leak rate of each adsorber bank shall be measured in accordance with Mandatory Appendix V.

8.8.3.3 Electric Heater Performance Test

With design air flow (+/- 10%) through each heater bank, the electrical supply voltage, amperage, phase balance of each heater circuit, and differential temperature and air flow across the heater coil shall be measured.

8.9 ADSORBENT IN-SERVICE TESTS

This Section provides the in-service laboratory test requirements for radioactive iodine penetration of the adsorbent bed used in carbon adsorber systems.

8.9.1 In-service Test Requirements

In-service laboratory tests shall be conducted, using representative samples of adsorbent, at least every 2 years, or 720* hours of accumulated service time, whichever is sooner. This test measures the penetration of radioiodine through adsorbent. Laboratory test results shall be evaluated to the acceptance limits of the Owner's Design Specification. Sample locations shall be selected to assure samples are representative of the overall condition of the adsorbent in the adsorber bank.

*NOTE: A documented history of adsorbent degradation may be used as a basis for review of the Design Specification or Technical Specification to establish a longer adsorbent sample interval.

8.9.2 Laboratory Analysis (LAB)

A laboratory analysis of the adsorbent shall be conducted in accordance with ASTM D-3803-89, to measure the ability of the adsorbent to remove radioiodine. Test bed depth used in the laboratory test shall be the same as the nominal adsorber depth in the adsorber bank being tested. Samples shall be representative of the oldest adsorbent in the bank and drawn from the bank test canisters, or from the bank itself. An in-place leak test of the bank shall be conducted following sample removal in accordance with Section 8.8, unless it can be demonstrated that the removal of the sample does not create a potential leak path around or through the adsorber bank. Sample adsorbent loaded in replacement test canisters shall be representative of the oldest adsorbent in the bank. If new adsorbent is used to replace the adsorbent removed for sampling, it shall not be used in future samples.

8.10 INTEGRATED SYSTEM TESTS

Each system shall be tested to verify that the functional performance at design operating conditions is achieved. Integrated system tests shall be conducted to challenge all integrated control functions including interlocks, and manual, or automatic actuation circuits, (damper position changes, fan starts and stops, compressor and pump starts or stops, valve position changes, heater energization or de-energization). These actuations can be from a number of different sources including radiation sensors, temperature sensors, chlorine sensors, pressure sensors, manual controls and emergency safeguard signals. Sensor operation shall be verified in addition to control circuitry. Integrated testing shall also include an overall system leak test to verify there are no unacceptable bypasses of the HEPA filter or adsorber banks. Integrated system testing shall verify that the intended design function of the system is achieved in accordance with the Owner's Design Specification. The maximum test interval for integrated system tests shall be 2 years.

8.10.1 Fan Integrated System Test Requirements (F)

Fans designed to respond automatically to a process or emergency actuation signal shall be tested. Sequencing of starts, stops and speed changes shall be conducted utilizing an actual or simulated actuation signal.

8.10.2 Air System Flow Balance Verification Test (Qf)

A verification of the system airflow balance shall be conducted. Recommended procedures include SMACNA, NEBB, ACGIH, AABC, or equivalent.

8.10.3 Damper Integrated System Test Requirements (F)

Dampers designed to respond automatically to a process or emergency actuation signal shall be tested. Sequencing of damper positions shall be conducted utilizing an actual or simulated actuation signal.

8.10.4 Refrigeration and Conditioning Integrated System Test Requirements (F)

Refrigeration and Conditioning equipment designed to respond automatically to a process or emergency actuation signal shall be tested. Sequencing of equipment operation (start, stop, speed change, valve operation or isolation heater operation) shall be conducted utilizing an actual or simulated actuation signal.

8.10.5 HEPA Filter and Adsorber Bank Integrated System Test Requirements (F)

All potential HEPA filter bank and adsorber bank bypass flow paths shall be challenged to verify that leak rates are within the Owner's Design Specification. Bypass flow paths may be challenged during the in-place leak testing, specified in Sections 8.7.3.2 and 8.8.3.2, by ensuring that the challenge aerosol or gas injection and sample ports encompass all potential bypass leak paths (reference Mandatory Appendix IV, step V-1100). If a potential bypass flow path is not challenged during these in-place tests, a separate test shall be performed, using the techniques outlined in Appendix IV or V, to verify that the HEPA or adsorber banks are not being bypassed in excess of the limits specified in the Owner's Design Specification.

9 TESTING FOLLOWING AN ABNORMAL INCIDENT

Following an abnormal incident in which the system has been challenged at or near its design capability, the applicable acceptance tests in ASME AG-1 Article TA-4000 shall be conducted to verify that the system is fully operational. Examples of abnormal incidents include a Design Basis or severe accident exposure of the HEPA filter or adsorber banks to radioactive particles or iodine (that may saturate the HEPA filter or adsorber banks), exposure to smoke, or chemical contaminants, flooding, fire, seismic event or over-pressurization. This requirement shall apply only to those components that may have been affected by the incident. An evaluation shall be conducted and documented to determine the extent of testing required.

Following exposure to smoke, solvent, paints, or other organic fumes or vapors, which could degrade the performance of the adsorbent, the adsorbent shall be replaced or verified functional by a laboratory test in accordance with Section 8.9.2.

10 CORRECTIVE ACTION REQUIREMENTS

Corrective action is required when test results do not meet the acceptance criteria specified. For equipment that is replaced, modified, or repaired, such that the reference values may change, a new set of reference values shall be obtained in accordance with the requirements of Section 4.2 and ASME AG-1 Article TA-4000. Additional guidance for corrective actions is included in Non-Mandatory Appendix B.

11 QUALITY ASSURANCE

11.1 General

Field testing of nuclear air treatment, heating, ventilating, and air conditioning systems shall be conducted in accordance with the quality assurance requirements of ASME AG-1, Article AA-8000, ANSI/ASME NQA-1, and NQA-2.

11.2 Personnel

Tests shall be conducted by personnel who have demonstrated competence to perform the specific tests, as evidenced by documented experience and training. Personnel shall be certified in accordance with ANSI/ASME NQA-1 or ANS 3.1, and in accordance with the Owner's Quality Assurance Program Requirements.

11.3 Documentation

In-service test procedures shall document the test results specified in Section 8 and include a record of test failures with subsequent corrective actions and analysis of test data trends. These records shall be maintained for the life of the facility.

11.3.1 Procedures

Written test procedures shall document the in-service testing performed and the test results obtained in accordance with Section 8 of this Standard.

11.3.2 Reports

A written report shall be provided to document the in-service testing performed in accordance with Section 8 of this Standard. The report shall contain, as a minimum, the following:

(a) The system name, test/inspection procedure(s) used, date of test results and the test performer's signature;
(b) Identification of instruments, equipment, tools and documents to the extent that they, or their equivalent, can be identified for future examinations;
(c) Observations and dimensional checks specified by the respective test data and any reports developed during the inspection and testing;
(d) Conclusions and recommendations by visual examinations and testing personnel;
(e) Reference to previous reports, if this report is for reinspection and testing.

APPENDIX I
MANDATORY
VISUAL INSPECTION CHECKLIST

I-1000 General

A specific inspection checklist for each component in the system shall be included in the in-service test procedures. This Appendix lists typical items for each component to be visually inspected in Section 8 (In-service Tests). The inspection shall be conducted in accordance with Section 6.1. The acceptance criteria for these inspections shall be in accordance with Section 7 and Section 7.1.

I-1100 Fan Inspection Checklist

a. Housing and duct interface
b. Fan belt and shaft guards
c. Interferences with moving parts
d. Fan shaft seal
e. Belt adjustment and condition
f. Lubricant levels
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Control system components
l. Pneumatic connections
m. Access for tests and maintenance

I-1200 Damper Inspection Checklist

a. Housing and duct interface
b. Actuator linkage, motor, controller
c. Interferences with moving parts
d. Damper shaft seal
e. Blade edge seals, damper seat
f. Limit switches
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Pneumatic connections
l. Access for tests and maintenance

I-1300 Duct, Housing and Mounting Frame Inspection Checklist

a. Housing and duct connections (no caulking)
b. Provision for opening access doors from both inside and outside
c. Access door seals, gaskets
d. Access door latches
e. Housing internal access ladders and platforms

f. Sample and injection ports, location and caps
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation, connections
j. Electrical connections
k. Housing/duct penetration seals
l. Loop seals (water level), drain connections
m. Lighting conduits, socket housing seals (flush mounted)
n. HEPA/adsorber mounting frame continuous seal welds
o. Mounting frame penetrations seal welded
p. Mounting frame seating surface (weld splatter, flatness, scratches)
q. Sample canister installation
r. Mounting frame clamping devices
s. Access for tests and maintenance
t. Lighting for test and maintenance available

I-1400 Refrigeration Equipment Inspection Checklist

a. Housing or duct interface with refrigeration equipment
b. Fan, pump, compressor belt and coupling guards
c. Interferences with moving parts
d. Belt adjustment and condition
e. Fluid leaks
f. Lubricant levels
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Control system components
l. Pneumatic connections and tubing (No crimping)
m. Access for tests and maintenance

I-1500 Conditioning Equipment Inspection Checklist

a. Housing or duct interface with conditioning equipment
b. Belt and coupling guards
c. Interferences with moving parts
d. Belt tightness
e. Fluid leaks
f. Lubricant levels
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Control system components
l. Pneumatic connections and tubing (No crimping)
m. Drains and spray nozzles not plugged
n. Access for tests and maintenance

I-1600 Moisture Separator Bank, Prefilter Bank, HEPA Filter Bank Inspection Checklist

a. Moisture separator media, frame, clamps and gaskets
b. Moisture separator water collection system and drains
c. Prefilter media, frame, clamps and gaskets
d. HEPA filter media, frame, clamps and gaskets
e. Sealant or caulking (none allowed)
f. Moisture separator, prefilter, HEPA orientation (vertical)
g. Bolting and fasteners.
h. Access for tests and maintenance

I-1700 Type II, Type III Adsorber Bank Inspection Checklist

a. Type II media, frame, screen, clamps and gaskets
b. Sealant or caulking (none allowed)
c. Type III media, screens, frame
d. Test canisters
e. Bulk loading equipment
f. Fire protection system piping, nozzles, instrumentation
g. Bolting and fasteners
h. Access for tests and maintenance

APPENDIX II
MANDATORY
DUCT AND HOUSING LEAK TEST PROCEDURE

II-1000 General

This procedure is used to test the leak tightness of the ducts and housings including installed fan housings, damper housings and fan and damper shaft seals.

II-1100 Summary of Method

Ducts and housings that form the pressure boundary of the system shall be leak tested, with air, using one of the methods listed in this procedure. Either method may be used and will produce a similar test result. The constant pressure method is useful for testing small volumes and is conducted at the maximum operating pressure for the system. The pressure decay method is useful in testing large volumes and is conducted by pressurizing to 1.25 times the maximum operating pressure, then allowing the pressure to decay for a fixed period of time, or until the pressure decreases to 80% of the maximum operating pressure, whichever occurs first. Fans, dampers, and other components that are part of the pressure boundary shall be installed and tested with the pressure boundary to verify interface connection leak tightness. If the measured leak rate is in excess of the acceptance criteria, the leaks shall be located by one of the methods listed in this procedure. After leaks are repaired, the duct and housing shall be re-tested to verify leak tightness.

NOTE: This test procedure is written as if the operating pressure were positive, but it would be identical for negative pressure systems with appropriate change in signs used in the data collection and calculations.

II-2000 Prerequisites

Construction, modifications and repairs affecting the test boundary shall be complete and the inlet and discharge openings of the duct or housing sealed before the test is started. All electrical, piping, and instrument connections shall be complete and all permanent seals shall be installed before the test is started. For pressure decay testing, the volume of the pressure test boundary must be calculated.

II-3000 Test Equipment

a. Pressurization source (Pneumatic, test fan with flow control, etc.).

b. Covers to seal test boundaries.

c. Clock or timer accurate to +/- 1.0 second.

d. Pressure indicating device accurate to +/- 0.1 in.w.g. (0.025

kPa(gage)).

e. Flowmeter or Totalizing Gas Volume meter accurate to +/-5% (constant pressure method).

f. Temperature indicating device accurate to +/- 0.5 °F (0.25°C).

g. Bubble solution for detecting air leaks (bubble method).

h. Optional portable electronic sound detection equipment (audible leak method).

i. Barometer

II-4000 Procedure

II-4100 Constant Pressure Test

a. Connect the pressurization source to the duct or housing.

b. Connect the flowmeter or totalizing gas volume meter between the pressurization source and the housing (downstream of the throttling valve, if used).

c. Install temperature and pressure indicating devices so that they will indicate representative temperature and pressure inside the duct or housing being tested.

d. Seal test boundaries and close access doors in the normal manner. Do not use temporary sealants, duct tape, or similar temporary materials except for sealing the temporary blank-off panels.

e. Start the pressurization source and operate it until the maximum operating pressure is achieved. Maintain pressure constant with the flow control device until temperature remains constant within +/- 0.5 °F (0.25 °C) for a minimum of 10 minutes. Record the initial stabilized pressure, temperature, and barometric pressure.

f. Measure the flow rate of the air being added to or removed from the duct or housing while maintaining the maximum operating pressure within +/- 0.1 in. w. g. (0.025 kPa(gage)). When using the flow meter, record flow readings once a minute for a 5 minute continuous period and average the readings to calculate the measured leak rate. When using a totalizing gas volume meter, measure the total volume of air for a 10 minute continuous period and divide the measured volume by time (10 minutes) to calculate the measured leak rate. Record final pressure, temperature and barometric pressure.

g. Convert the final calculated leak rate to standard cubic feet per minute (cubic meters per second) in accordance with the method illustrated in "Industrial Ventilation" (ref. Section 2).

II-4200 Pressure Decay Test

a. Connect the pressurization source (with a leak tight shutoff valve) to the duct or housing.

b. Install the temperature and pressure indicating devices where they will indicate the representative temperature and pressure inside the duct or housing being tested.

c. Seal test boundaries and close access doors in the normal manner. Do not use temporary sealants, duct tape, or similar temporary materials except for sealing the temporary blank-off panels.

d. Start the pressurization source and operate until the pressure is 1.25 times the maximum operating pressure (but not to exceed the structural capability pressure). Maintain this pressure constant with a flow control device until temperature remains constant within +/- 0.5 °F (0.25 °C) for a minimum of 10 minutes. Close shutoff valve.

NOTE(1): If the structural capability pressure for the duct or housing is less than 1.25 times the maximum operating pressure, the final test pressure shall be calculated as follows to achieve an average test pressure equal to the maximum operating pressure:

$$Pf = 0.8(OP_{max}) + (1.25(OP_{max}) - SCP)$$

where: Pf = final test pressure
OP_{max} = maximum operating pressure
SCP = structural capability pressure

e. Record the initial time, pressure, temperature, and barometric pressure.

f. Record pressure readings once a minute until pressure decays to 80% of the maximum operating pressure, or for a minimum of 15 minutes (see NOTE(1) in step d above).

h. Record final time, pressure, temperature, and barometric pressure.

i. Calculate leak rate from the following equation in English Units:

$$Q_{ave} = \left(\frac{Pi}{Ti} - \frac{Pf}{Tf} \right) * \frac{V}{R*\Delta t*0.075}$$

Metric Units:

$$Q_{ave} = (1.39 * 10^{-5}) * \left(\frac{Pi}{Ti} - \frac{Pf}{Tf}\right) * \frac{V}{R*\Delta t}$$

where:

Q_{ave} = Average leak rate, scfm (sm^3/s). (air density 0.075 lb/ft3)

V = Volume within test boundary, ft^3 (m^3).

P_i = Initial pressure within test boundary, lb/ft^2 ABS (Pa(absolute)).

P_f = Final pressure within test boundary, lb/ft^2 ABS (Pa(absolute).

T_i = Absolute Temperature at start of test, °R (°K).

T_f = Absolute Temperature at end of test, °R (°K).

Δt = $t_i - t_f$ Time difference (minutes).

t_i = Time at start of test (minutes).

t_f = Time at end of test (minutes).

R = Gas Constant for Air; 53.35 $\frac{ft\text{-}lb}{lb\text{-}°R}$, (0.286 $\frac{kJ}{kg\text{-}°K}$)

II-4300 Acceptance Criteria

If the calculated leak rate exceeds the Owner's acceptance criteria, locate leaks in accordance with one of the techniques outlined in II-4400 or II-4500.

II-4400 Bubble Leak Location Method

a. Pressurize the test boundary to the maximum operating pressure for the system.

b. With the test boundary under continuous pressure, apply bubble solution to areas to be tested. Identify places where bubbles are found and perform corrective actions.

c. Following corrective actions, retest in accordance with II-4100 or II-4200.

II-4500 Audible Leak Location Method

a. Pressurize the test boundary to the maximum operating pressure for the system.

b. With the test boundary continuously pressurized, locate audible leaks (electronic sound detection equipment optional) and perform corrective actions.

c. Following corrective action, retest in accordance with II-4100 or II-4200.

APPENDIX III
MANDATORY
AIRFLOW DISTRIBUTION TEST PROCEDURE

III-1000 General

This procedure is used to measure the air flow distribution across the face of moisture separator, prefilter, HEPA filter, and adsorber banks. Uniform air velocity distribution ensures maximum air treatment efficiency and uniform loading of air treatment components.

III-1100 Summary of Method

The system is operated at design flow rate. Airflow velocity readings are measured downstream of each moisture separator, prefilter, and HEPA filter in the bank. For adsorbers, readings shall be taken in line with the flow slots. Each reading is compared to the average for the bank.

III-2000 Prerequisites

System operating within +/- 10% design flow rate.

III-3000 Test Equipment

Rotating vane, heated wire or heated thermocouple anemometer, pitot tube, or other suitable air velocity measuring device as appropriate for the anticipated velocities.

III-4000 Procedure

a. For each moisture separator, prefilter and HEPA filter, measure the air velocity at the approximate centers of equal areas with at least 1 measurement per each moisture separator, prefilter, and HEPA filter, and a minimum of 9 measurements per bank. Adsorber velocity measurements shall be made in the approximate center of the flow slots. For flow slots greater than 24 inches long (60 cm), measurements shall be nominally every 12 inches (30 cm) along the length of the slot.

b. Calculate the average velocity (V_{ave}) using the following formula:

$$V_{ave}=\frac{\sum_1^n V_i}{n}$$

where:

$\sum_1^n =$ sum of readings from 1 to n

V_i = individual velocity readings
n = number of readings

c. Identify the highest and lowest velocity readings and calculate the percentage they vary from the average calculated above.

APPENDIX IV
MANDATORY
HEPA FILTER BANK IN-PLACE LEAK TEST PROCEDURE

IV-1000 General

This procedure is used to leak test HEPA banks.

IV-1100 Summary of Method

The system is operated at design flow rate. Challenge aerosol is injected upstream of each bank through the injection ports qualified in Acceptance Testing in ANSI/ASME AG-1 Appendix TA-V. The concentration of the challenge aerosol is measured upstream and downstream of the HEPA bank. The ratio of the downstream and upstream concentrations represents the HEPA filter bank leak rate.

IV-2000 Prerequisites

Airflow distribution shall be verified in accordance with Appendix III. The injection port shall be qualified to provide uniform air-aerosol mixing in accordance with ASME AG-1 Appendix TA-V.

IV-3000 Test Equipment

a. Challenge aerosol generator.

b. Challenge aerosol measuring instrument.

c. Flow measuring device.

IV-4000 Procedure

a. Connect challenge aerosol or gas generator to the qualified injection port.

b. Place the challenge aerosol or gas measuring instrument sample probes upstream and downstream of the bank to be tested with adequate hose length to reach all areas of the bank.

c. Start the system and verify stable flow rate within +/- 10% of design flow rate.

d. Measure the upstream and downstream aerosol background concentration. The pre-injection background levels shall be stable to ensure correct instrument response and shall not interfere with the detector's ability to detect leaks in excess of the maximum allowed by the acceptance criteria.

e. Start the challenge aerosol injection.

f. Record the upstream and downstream concentrations. Repeat until at least three of the readings are stable.

g. Stop the injection.

h. Using the final set of readings meeting the stability and tolerance criteria, calculate the bank leak rate using the formula below:

$$L = (100) \frac{C_d}{C_u}$$

L = % Leak
C_d = Downstream concentration
C_u = Upstream concentration

APPENDIX V
MANDATORY
ADSORBER BANK IN-PLACE LEAK TEST PROCEDURE

V-1000 General

This procedure is used to leak test adsorber banks.

V-1100 Summary of Method

The system is operated at design flow rate. Challenge gas is injected upstream of each bank through the injection port qualified in ASME AG-1 Appendix TA-V. The concentration of challenge gas is measured upstream and downstream of the bank. The ratio of the downstream and upstream concentrations represents the bank leak rate.

V-2000 Prerequisites

Airflow distribution shall be verified in accordance with Appendix III. The injection port shall be qualified to provide uniform air-aerosol mixing in accordance with ASME AG-1 Appendix TA-V.

V-3000 Test Equipment

a. Challenge gas generator.

b. Challenge gas measuring instrument.

c. Flow measuring device.

V-4000 Procedure

a. Connect challenge gas generator to the qualified injection port.

b. Place the challenge gas measuring instrument sample probes upstream and downstream of the bank to be tested. The sample tubing shall be of equal lengths and bore and as short as possible to minimize the measuring instrument response time. The upstream sample probe shall be located in approximately the center of the bank. The downstream sample probe shall be located in a downstream sample manifold or downstream of a mixing source such as a turbulent fan discharge.

c. Start the system and verify stable flow rate and within +/-10% of design flow rate.

d. Measure the upstream and downstream challenge gas background concentration. The pre-injection background levels shall be stable to ensure correct instrument response and shall not interfere with the detector's ability to detect challenge gas leaks less than the maximum allowed by the acceptance criteria.

e. Start the challenge gas injection.

f. Record the upstream and downstream concentrations, as rapidly as instrument response time allows, until sufficient data has been recorded to allow calculation of adsorber bank leak rate. Care must be taken to obtain sufficient readings quickly after injection.

g. Terminate challenge gas injection.

h. Using the upstream and downstream concentration data, calculate the adsorber bank leak rate using the formula below.

$$L = (100) \frac{C_d}{C_u}$$

L = % Leak
C_d = Downstream concentration
C_u = Upstream concentration

APPENDIX A
NON-MANDATORY
MOUNTING FRAME PRESSURE LEAK TEST PROCEDURE

A-1000 General

This optional test is used to identify leaks through seal welds of the HEPA filter or adsorber mounting frames. The presence of these leaks may be evident when conducting the in-place leak tests on the HEPA filter and adsorber banks. A good visual verification per Appendix I, steps I-1600 and I-1700, is usually adequate. This procedure is provided for use when the frame leaks need to be located.

A-1100 Summary of Method

Temporary blanks, with gaskets, are installed in place of the HEPA filters or adsorbers on the mounting frame in the system. The pressure boundary is then secured by blanking off upstream of the mounting frame in the housing or associated ducts. This modified pressure boundary is then pressurized using the techniques outlined in Appendix II and any leaks in the mounting frame welded interface is detected using the techniques in Appendix II, steps II-4400 or II-4500.

A-2000 Prerequisites

Construction, modifications and repairs affecting the test boundary shall be complete and temporary blanks, with gaskets, installed on the gasket side of the mounting frame. The opening of the duct or housing upstream of the mounting frame shall be blanked off to form a modified pressure boundary.

A-3000 Test Equipment

a. Pressurization source (test fan with flow control).

b. Covers to seal test boundaries.

c. Pressure indicating device accurate to +/- 0.1 in. w.g. (0.025 kPa(gage)).

A-4000 Procedure

a. Connect the pressurization source to the duct or housing pressure boundary.

b. Install pressure indicating device so that it will indicate the pressure inside the duct or housing being tested.

c. Close access doors.

d. Start the fan and operate until the pressure is greater than or equal to the maximum operating differential pressure for the filter bank (not to exceed the structural capability pressure for the duct and housing assembly). Maintain pressure for the duration of the inspection.

e. Inspect the mounting frame welds and attachments for leaks using the methods outlined in Appendix II, steps II-4400 or II-4500.

APPENDIX B
NON-MANDATORY
CORRECTIVE ACTION GUIDANCE

Corrective action may consist of replacement, repair, modification, maintenance, or analysis to demonstrate that the equipment will fulfill its design function. A revised set of reference values, as described in Section 4, shall be established after the corrective action has been taken.

Results of a failed test shall not be resolved simply by a successful repetition of the test. A successful repetition of the test shall be preceded by corrective action.

If the cause of the test failure cannot be determined by inspection or analysis, corrective action may consist of re-calibration of test instruments and subsequent re-testing. If it is determined that the test failure is due to an equipment malfunction, instead of difficulties with the test equipment, or test procedure, the equipment shall be declared unavailable for service until the specific cause has been determined and the condition corrected.

APPENDIX C
NON-MANDATORY
CHALLENGE GAS SUBSTITUTE SELECTION CRITERIA

Alternative test agents (challenge gas) may be used to perform In-place testing of adsorbers, as required in Mandatory Appendix V, when their selection is based upon meeting the following characteristics:

1. The test agent gives the same In-place Leak Test results as one of the following: R-11, R-12, R-112, or R-112a.

2. The test agent has similar retention times on activated carbons, at the same concentration levels, as one of the following: R-11, R-12, R-112, or R-112a.

3. The test agent has similar lower detection limit sensitivity and precision in the concentration range of use as one of the following: R-11, R-12, R-112, or R-112a.

4. The test agent exhibits chemical and radiological stability under the test conditions.

5. The test agent causes no degradation of the carbon and its impregnant(s) or of other Nuclear Air Treatment System components under the test conditions.

6. The test agent is listed in the Environmental Protection Agency "Toxic Substance Control Act" (TSCA) inventory for commercial use.

APPENDIX D
NON-MANDATORY
TEST PROGRAM DEVELOPMENT GUIDANCE

D-1000 OVERVIEW:

The scope of the periodic in-service test program for nuclear safety-related air treatment, heating, ventilating, and air conditioning systems should be developed commensurate with the safety significance of the system performance function(s). The overall depth of the performance monitoring effort should be flexible, with various tests being added, modified, or deleted as results and industry experience warrant. This Appendix will attempt to provide the user with guidance in developing a test program which will meet the requirements of the Standard.

D-2000 DEFINITIONS:

The following definitions are applicable to this Appendix:

Analyzed System Configuration: The alignment and condition (on or off) of various components, handswitches, controls, valves, piping, etc., that have been analyzed as being capable of accomplishing a specific system function.

Analyzed System Performance: The predicted performance as determined in the appropriate analysis (safety, system, or component analysis) or the acceptable limit as defined in the Technical Specification Basis. This value is in the conservative direction when related to the design limit, with the difference between the two defining the analysis margin.

Design Basis: "That information which identifies the specific functions to be performed by a structure, system, or component of a facility, and the specific values or range of values chosen for controlling parameters as reference bounds for the design. These values may be (1) restraints derived from generally accepted "state of the art" practices for achieving functional goals, or (2) requirements derived from analysis (based on calculation and/or experiment) of the effects of a postulated accident for which the structure, system, or component must meet its functional goals". (REF: 10CFR50.2)

Parameters: The variables or measurable qualities of a system or component that define acceptable operation or can be restricted to ensure that performance remains within design limits.

System Performance Function: The goal or task which the system is required to accomplish or support.

Examples of System Performance Functions, which might be applicable to nuclear air treatment, heating, ventilating and air conditioning systems include:

I. Provide a habitable environment (temperature, humidity, filtration, ventilation) for facility personnel.
II. Provide an acceptable environment (temperature, humidity, ventilation) to support equipment operability and Environmental Qualification requirements.

III. Prevent the uncontrolled release of airborne radioactivity and limit offsite dose in accordance with 10CFR50 Appendix I, 10CFR20 and 10CFR100.

D-3000 TEST PROGRAM DEVELOPMENT:

The Owner should perform a detailed review of all design basis documentation applicable to each safety-related system. Subsequent to this review, a Test Basis Document should be prepared for each nuclear safety-related air treatment, heating, ventilating, and air conditioning system in the facility to identify the following:

1. System safety-related performance function(s)
2. Analyzed system configuration for each identified performance function.
3. The critical performance parameters which will define acceptable system operation for each performance function.
4. The Parameter design limits. These are the design or analysis limits which govern the system performance and bound the system.

NOTE: The Nuclear Management and Resources Council, Inc (NUMARC) sponsored document "Design Basis Document Guidelines", NUMARC 90-12, October 1990 and USNRC NUREG-1397, "An Assessment of Design Control Practices and Design Reconstitution Programs in the Nuclear Power Industry", February 1991, can provide further detail on methods for determining the various design basis functions.

D-4000 SAMPLE TEST PROGRAM:

Given a sample Control Room Complex Emergency HVAC System, consisting of a fan, ductwork, dampers, chilled water cooling coils, nuclear air filtration unit (electric preheater,prefilter, HEPA filters, Adsorber), controls, etc., the System Test Basis Document might be structured as follows:

A. System Performance Functions:

1. Provide a habitable environment for control room complex personnel in the event of a design basis accident
2. Maintain the control room complex environment to ensure equipment operability.
3. Limit radiological dose to control room complex personnel in accordance with GDC-19 requirements

B. Analyzed System Configuration:

To achieve Performance Functions A1, A2 and A3:

One Essential Air Filtration unit in service, normal ventilation system isolated and an essential chilled water system in service.

C. **Critical Performance Parameters and Parameter Design Limits:**

Performance Function	Performance Parameters	Parameter Design Limit
A1 and A2	Heat Removal:	850,000 Btuh
	* Total System Airflow	30,000 SCFM (min)
	* Air Temperature at coil outlet	60 °F (Max)
	* Chilled Water Flow to coil	114 GPM (Min)
	* Chilled Water Supply Temperature	45 °F (Max)
	* Control Room Ambient Air Temperature	80 °F (Max)
A3	Radiation Protection:	
	* Outside Airflow (pressurization)	400 SCFM (Min)
	* Outside Airflow	900 SCFM (Max)
	* HEPA Filter Bypass Leakage	1% (Max)
	* Adsorber Bypass Leakage	1% (Max)
	* Adsorbent Methyl Iodide Removal Efficiency	99% (Min)
	* Humidity Control At Adsorber	70% (Max)
	* Control Room Complex Pressure	+0.25 in. wg (relative to all adjacent areas)
	* Isolation Damper Leakage	Bubbletight @ 15 in wg
	* Isolation Damper Closure Time	25 seconds (Max)
	* Filter Unit Total Pressure Drop	8.0 in. wg (Max)

Based upon the identified Critical Performance Parameters for the sample Control Room Complex Emergency HVAC System, the following periodic in-service test program would be appropriate:

Test Section	Test Description	Test Applicable to System?	Test Frequency
8.2	FANS	YES	
8.2.2	Visual Inspection (VT)	YES	Q
8.2.3	Pressure Boundary Test		
8.2.3.1	Leak Test (PL)	YES	10Y
8.2.4.1	Mechanical Run Test (F)	YES	Q

8.2.4.2	Flow Rate Test (Qf)	YES	2Y
8.2.4.3	Static Pressure Test (DP)	YES	2Y
8.2.4.4	Rotational Speed Test (N)	YES	2Y
8.2.4.5	Vibration Test (Vb)	YES	Q
8.3	DAMPERS	YES	
8.3.2	Visual Inspection (VT)	YES	2Y
8.3.3.1	Leak Test Damper Seat (PL)	YES	2Y
8.3.4.1	Position Indication Test (F)	YES	2Y
8.3.4.2	Exercise Test (F)	YES	2Y
8.3.4.3	Static Timing Test(F)	YES	Q
8.3.5.1	Flow Control Test (F)	YES	2Y

Test Section	Test Description	Test Applicable to System?	Test Frequency
8.3.5.2	Fire Damper Test (F)	YES	2Y
8.3.5.3	Dynamic Timing Test (F)	YES	2Y
8.3.5.4	Interlock Test (F)	YES	2Y
8.4	DUCT AND HOUSING	YES	
8.4.2	Visual Inspection (VT)	YES	2Y
8.4.3.1	Leak Test (PL)	YES	10Y
8.5	REFRIGERATION EQUIPMENT	NOTE 1	
8.5.2	Visual Inspection (VT)		
8.5.3.1	Leak Test, Refrigerant Piping and Coil (PL)		
8.5.3.2	Leak Test, Hydronic Piping and Coils (PL)		
8.5.4.1	Valve Position Indication (F)		
8.5.4.2	Valve Exercise Test (F)		
8.5.4.3	Valve Timing Test (F)		
8.5.5.1	Flow Control Valve Test (F)		
8.5.5.2	Mechanical Run Test (F)		
8.5.5.3	Performance Test (F)		
8.5.5.4	Vibration Test (Vb)		
8.5.5.5	Rotational Speed Test (N)		
8.6	CONDITIONING EQUIPMENT	NOTE 2	
8.6.2	Visual Inspection (VT)		
8.6.3.1	Leak Test, Hydronic Piping and Coils (PL)		
8.6.4.1	Valve Performance Tests (F)		
8.6.5.1	Hydronic System Flow Balance Verification (Qf)		
8.6.5.2	Flow Control Valve Test (F)		
8.6.5.3	Mechanical Run Test (F)		

8.6.5.4	Performance Test (F)		
8.6.5.5	Rotational Speed Test (N)		
8.6.5.6	Vibration Test (Vb)		
8.6.5.7	Electric Heater Test (AMP)		
8.6.5.8	Hydronic Heating and Cooling Performance Test (F)	YES	2Y
8.7	MOISTURE SEPARATOR, PREFILTER, HEPA FILTER BANK		
8.7.2	Visual Inspection (VT)	YES	2Y
8.7.3.1	Differential Pressure Test (DP)	YES	M
8.7.3.2	In-Place Leak Test (IP)	YES	2Y
8.8	TYPE II and TYPE III ADSORBER BANK		
8.8.2	Visual Inspection (VT)	YES	2Y

Test Section	Test Description	Test Applicable to System?	Test Frequency
8.8.3.1	Differential Pressure Test (DP)	YES	M
8.8.3.2	In-Place Leak Test (IP)	YES	2Y
8.8.3.3	Electric Heater Performance	YES	2Y
8.9	ADSORBENT		
8.9.2	Laboratory Analysis (LAB)	YES	2Y
8.10	INTEGRATED SYSTEM TESTS	NOTE 3	
8.10.1	Fan Integrated System Tests (F)	YES	2Y
8.10.2	Air System Flow Balance Verification (Qf)	YES	2Y
8.10.2	Damper Integrated System Test (F)	YES	2Y
8.10.3	Refrigeration and Conditioning Integrated System Test (F)	NOTE 1	
8.10.4	HEPA Filter and Adsorber Bank Integrated Test (F)	YES	2Y

NOTES:

1. Refrigeration Equipment is scoped and tested with the Essential Chilled Water System.
2. Conditioning Equipment, with the exception of the Control Room Complex Essential Cooling Coil, is scoped and tested with the Essential Chilled Water System.

3. Measurements for Control Room Complex pressure and ambient room temperature are incorporated into 8.10, Integrated System Testing.

DISCUSSION

PEST: I am a member of the ASME Committee on Nuclear and Gas Treatment and serve as vice-chairman of the Subcommittee on Field Test Procedures, and chairman of the Subgroup of the same name. I am employed at the Palo Verde Nuclear Generating Station, operated by Arizona Public Service Co., the nation's largest electrical power producing site. At this session we will be discussing the proposed AG-1 Code, Section TA, Acceptance Testing, and the proposed Standard N511, Periodic In-Service Testings of Nuclear Air Treatment, Heating, Ventilating and Air Conditioning Systems. I plan to give a brief history of the two documents, why they are needed., and familiarize you with the development process. After a brief review of the contents of the documents, I will ask the panel for comments.

In 1971, a group was organized to develop standards for high reliability air cleaning equipment and a performance test. The result was ANSI/ASME N510, published in 1975 and ANSI/ASME N509, published in 1976. These two standards were updated in 1980, again in 1989, and reaffirmed recently. It appears that they will live on for some time as they are now considered international standards.

The scope was expanded to include ancillary components and systems and the development of an equipment code. The first edition of the code, AG-1, was issued in 1986 and reapproved in 1988 and 1994. Section TA has been in preparation for a number of years. Approximately three years ago, draft Section TA covering acceptance and in-service testing was approved by the CONAGT Main Committee but rejected by the Board of Nuclear Codes and Standards with instructions to make Section TA cover acceptance testing, only. CONAGT resolved to provide a separate standard for in-service testing. Section TA, revision 03-06-96, was sent to the Main Committee for letter ballot but was not approved. It is the subcommittee's intent to prepare responses to negative ballots, and submit a redraft to the Main Committee for approval by August 2, 1996. This means that it could be in print by late 1997.

The proposed in-service testing standard, designated N511-19XX, has just completed the first subcommittee ballot and some changes are needed. The subcommittee intends to prepare responses to all comments, review newly-derived issues, and distribute a new draft for subcommittee ballot by approximately August 15. We believe that the information gained from this session will help us prepare a quality document in a short time. N511 is intended for application to systems built according to provisions of the AG-1 code. This is the same relationship as N510 to N509.

As we review these documents together I am going to read certain paragraphs and tell you what is going to be changed. To TA 2000 we will be adding the latest edition of the references. For TA 3500, the second sentence which reads, "Test results are considered acceptable if the component or system is not impaired or degraded to the point that it cannot perform its intended function" will be deleted. The consensus was that the phrase did not give the correct emphasis. To TA 4010, a note will be added that repairs or maintenance procedures that do not affect test acceptance values will not require a retest. For TA 4436, the first sentence will read, "Correct direction of rotation shall be verified for compressor motors." Because it is not wise to start and stop a compressor motor just to see if it is rotating in the correct direction and because some compressor motors are hidden within the system, verification will have to be performed by electrical means. In the second sentence, we will change restart to start. A caution note will be added to TA 4736 to require monitoring air temperature leaving the heater to avoid challenging the fire protection systems and causing automatic actuations. To TA 4740, acceptance criteria, will be added paragraph 4744, Electrical Heater Performance Test Acceptance Criteria. For TA 4940 after the words "flow path" will be added the words, "housing, by-pass ducts, and associated dampers." In

Appendix TA-1, page 41, a sentence will be changed to read, " provisions for access for performing tests and maintenance." These are all the changes to the balloted Section TA document.

The copy of N511 in your hands is about two revisions old. We have had several word smithing sessions. Appendix A will be deleted. In Section 8.10.2, there will be further work on air balance verification. This was brought up this week in our subcommittee meeting. There was a lot of discussion about what you have to do to certify that the system is balanced. Do you do a traverse at the fan or do you have to go back through the branch ducts and the diffusers? Do you perform temperature surveys? We also need to consider test requirements for medium efficiency filters in N511 and the matter of the test designators that were transferred from Section TA. Through this session, we can smooth out the document before it gets to the Main Committee.

Panel Members are Curt Graves, NUCON, International, Paul Burwinkel, Georgia Power, Vince Kluge, Palo Verde Nuclear Generating Station, and Len Leonard, Leonard Designs. Now, we will open the session for discussion.

<u>SCRIPSICK:</u> I am not certain I have reviewed the entire document. There are sections in N509 that pertain to testing HEPA filter systems. An example is the mandatory appendix for qualification of injection and sampling manifolds. Does that topic appear in either of the two documents, or are there still going to be some provisions in N509 for testing?

<u>PEST:</u> The housing group will try to include some information on locations for sample manifolds.

<u>KLUGE:</u> I think that section TA can only address the sections of AG-1 that have been approved. Manifolds are within the housing group, and that section has not been issued. But when it is, it will be addressed.

<u>SCRIPSICK:</u> It seems to me that considerations for sampling downstream should be an essential part, just as aerosol mixing is included in a mandatory appendix.

<u>PEST:</u> As I see it, N509 would continue to contain acceptance criteria for injection points but the in-service document would describe how you test it.

<u>SCRIPSICK:</u> There is a requirement of ±20% for air flow distribution and air/aerosol mixing on the upstream side but not for sampling downstream, I don't see any reason to treat it differently.

<u>GRAVES:</u> This document is still a work in progress, as other code sections are developed this group will take over the testing portion for them. Until a code section is developed that addresses the component that needs to be tested, this group does not produce anything, although they can anticipate. Did I hear you say sampling manifolds are in the housing section?

<u>KOVACH, L:</u> The basic idea is that the qualification requirements for mixing and test manifolds are in the TA section because if you qualify them on the original system, as it was built, it is not expected that they will change in use. TA requires you redo the qualification procedure if you make changes. Therefore, after you qualify the injection and test locations, N511 gives you the surveillance tests that you need thereafter. It is not expected that it would change as long as you maintain the same flow rate and configuration. But if you change the configuration, you would have to do the TA-type acceptance testing.

This will make N511 less free-standing, because it could be applied to systems that are already qualified according to TA.

SCRIPSICK: My point is that TA does not consider the downstream side, once you qualify the downstream sampling location, you do not have to do it again. That is a major modification. I was not involved and do not know the history, but it seems to me that this is a good point to bring in all the considerations of downstream sampling. I do not understand the reason for treating the two differently.

KOVACH, L: TA covers everything relating to sampling locations that was in N509.

SCRIPSICK: But the qualification criteria for downstream sampling are not in TA.

KOVACH, L: I am not sure, I think it may be in there.

SCRIPSICK: Traditionally, it has been in N509.

KOVACH, L: It is not in N511 because it is expected that it will have already been taken care of.

SCRIPSICK: So it should be in TA, but I do not see it in TA. The concentration profile has to be ±5% to qualify a standard probe and the in-service probe or manifold has to be within ±5% of the standard probe.

KOVACH, L: What you have to understand is that there is segmentation now. Some of the things that you saw in N509 may now be in three or four different AG-1 sections. Now, when you build a housing, you will qualify the various injection ports and sampling locations with the housing. That is how it should be done, not after you build the unit. You do not start drilling holes in the housing like Woody Woodpecker to try to find the best location to test.

SCRIPSICK: I think that same logic should apply to the selection of the injection port.

KOVACH, L: You have be careful because the manufacturer of the housing may not construct the whole system, someone else may put in the HEPA filters, *etc*. Therefore, you must have enough flexibility to allow for commercial practice and make sure that you do not put in any code section specifications that belong to another manufacturing or supply step.

WILHELM: What are the results of the tests done up till now? What is the percentage of reactor filters or systems that really failed? Around twenty years ago, a paper was given that showed 15% of filters failed the test. I do not know the current percentage of failed filters. The in-place test is rather complicated and expensive. Is it really necessary, judging from the results you have today?

GRAVES: The point of the in-place test is to verify that after filter change-out or some other event the system still functions properly and there is no leak. In any case, NRC dictates that tests be performed at nuclear power plants. It is not a test of individual filters, it is a system test to make sure there is no bypass leakage or potential contamination path. It is assumed that the filters left the factory in good shape, and that they looked good when they were installed. After they are installed you want to know that the system does not have bypass leakage. I do not have any idea what percentage of filters failed as a result of the performance of these tests.

HAYES: Can you tell me whether section TA or N511 has any test associated with the integrity of a particular building or area boundary, such as a control room, auxiliary building, shield building, annulus reactor building? If they are included, what are the tests?

KLUGE: That would occur under integrated system testing, but currently, there is nothing specific as far as identifying such items as control room pressure envelope testing, or auxiliary building testing. However, in non-mandatory Appendix C, there is guidance on developing your own in-house program. N511 gives the levels of testing required and then you have to adapt it to your own facility, using your own design basis and the critical functions of your system. We identified pressure envelope testing as one of the things that should be addressed.

WEIDLER: I would like to hear some discussion from the panel regarding the benefits of Section TA and N511 versus the requirements of N509 and N510.

LEONARD: As we see it, TA and N511 will perform the same function for AG-1 systems that N510 performs for N509 systems. You have a design document, AG-1, and an acceptance test, TA, and an in-service test, N511.

BURWINKEL: A benefit of the TA section is that it addresses a large number of components of the overall systems in addition to the filter housing, as N510 tended to do just filter housing. There are sections on refrigerating equipment, there are sections on system performance, not just filtration.

PEST: I may add that when you are using N510 and N509 you are usually testing or building a flange-to-flange component, whereas Section TA, being an in-service testing document, encompasses the ancillary and working parts of the entire system, including any systems that may interact with your air conditioning unit. The advantage of N511 over N510 is that it will help when the NRC maintenance rule takes effect. Some people had thought the maintenance rule only applied to highly important systems, but we are finding out that it is not so. N510 is too restrictive, so we see that we have some room to grow with N511.

FIRST: We have heard a lot through the years about the difficulties of applying the latest versions of N510 and AG-1 to existing power plants that have Technical Specifications based on earlier documents; even in some cases predating the establishment of codes and standards. How are we going to adapt these new versions to the older plants? How are we making them user-friendly so that they can bring their testing procedures into the 1996 era from, say, 1976? This is always a matter of great concern to the users of these documents. Has some thought been given to how they will be made more adaptable than prior documents?

BURWINKEL: For years we have hidden behind the excuse that our Tech. Specs. have out-of-date parameters that conflict with the latest standards and codes. A couple of things ought to be done, first, I think it is the utilitys' responsibility to modify their Tech. Specs. so that they are accurate and current. When that is done, the Tech. Specs. are usually brought up to the latest codes and standards. Second, there is an initiative for utilities to adopt improved tech. specs. that coincide with the latest codes and standards.

GRAVES: I think what Dr. First was asking was, how do you use the new documents with old equipment, and what headaches will you run into there? You will always have those headaches. Some of the older equipment that was not designed to N509 requirements, and certainly not to the AG-1 code, is not easily testable in accordance with the latest versions of these documents. Careful thought is required to meet the intent, but there may be cases where you can not meet the letter of the test requirements. Tech. Spec. fixes might be helpful, but we are sometimes just stuck.

SCRIPSICK: One of the reasons I am interested in downstream sampling is that I see the uncertainty in test results from HEPA filter in-place testing as having several components. One is the air/aerosol mixing test requirement, ±20%. Another is air flow uniformity, a third is an error associated with downstream sampling. Combine all those uncertainties and you come up with an overall uncertainty that is related to the test result, what I call testing geometry effects, poor mixing upstream or downstream and non-representative sampling. Instead of looking independently at specific criteria of ±20% for concentration profile, ±20% for air flow across the bank, and criteria for downstream distribution, why not combine them and come up with an estimate of overall uncertainty? For non-standard systems this has the benefit that should you be out of specification for one or two items, or even three, you may be within your performance acceptance limit, by an increment that is related to the uncertainty because of offsetting effects. Instead of having a test result of 0.05% for non-standard systems that determines that the system performance is acceptable, it might be 0.01 or 0.02%. By having that offset, you account for some of the differences relative to the specifications. That is a plug for my paper tomorrow, but I would appreciate any reaction on that kind of an approach.

BURWINKEL: I do not believe that we can look at the errors in the sampling procedure and the errors in the challenge agent, and balance them off. If you do not have good air/aerosol mixing you may very well not be challenging a part of the bed that is not leak-tight. When I am not challenging part of the bed, I am not getting any test agent downstream. Because of that I do not see a ready relationship to not challenging part of the bed and having fewer errors in the sample. I do not really see a relationship between the two.

GRAVES: It is clear that for the test to mean something you have got to challenge the filtration device in question. If you can't do it correctly, you need to do something about how you are testing it. You need to make corrections there.

SCRIPSICK: I agree. One of the things our analysis has brought out is that ±20% for air/aerosol mixing is an extremely important criterion. On the other hand, ±20% for air flow uniformity distribution over the bank does not seem to make much difference in our analysis. I can understand that from the error propagation analysis that we have done. I also understand it from the context that the tests are performed in. When you have a non-uniform air-flow distribution for your test, the challenge is going to be non-uniform so that contributes to the uncertainty of your test result.

GRAVES: Not necessarily. You may have a non-uniform distribution because of where you are injecting.

SCRIPSICK: No, I am referring to the air flow distribution, not the air/aerosol mixing. It is quite likely that when your test aerosol is not completely mixed you are going to have a difference between the test aerosol distribution over the bank and your air distribution over the bank. That is a serious problem. In the algorithm that we have developed, air/aerosol uniformity comes out to be extremely important. When you do a very good job on that you are going a long way in reducing the uncertainty in your test result measurement. But airflow distribution over the bank does not play as important a role.

KOVACH, L: Please remember that we are dealing not only with particulate filters in these systems, but adsorption systems, also. In adsorption systems, ±20% flow does have a significant effect. Remember that these requirements are based on the MPP system tests that are in MPP-type air cleaning systems, most of which do contain adsorption units that are very strongly affected by airflow velocity and the capacity of the total test. If we are applying the requirement solely for the aerosol filtration test, your comment that the air/aerosol mixing is far more important than the airflow velocity uniformity through the HEPA filters is certainly correct. But when we are dealing with adsorption systems, airflow velocity becomes very important also.

PORCO: From what I understand your code sections address qualification testing of equipment. It also addresses initial installation testing of the equipment and in-service testing. Can we have a discussion on what are the differences and how your code sections address those differences?

KLUGE: The individual sections of AG-1 have their own requirements for factory qualification tests for individual components. What we are addressing in TA is the installed system, and the acceptance tests required to verify that it meets design requirements. N511 covers periodic retesting to verify the system continues to meet design requirements . You will find factory testing in the individual sections of the code, not within TA.

PEST: N511 will have surveillance requirements. When you do your TA acceptance testing you establish your baseline test reference values for acceptability. Requirements for a trending program are in N511 so you will be able to balance new test values against those in the past. When you have a degrading trend, you know that corrective actions have to take place. We looked at all the acceptance tests in TA and tried to include them in N511 for periodic reverification.

FRETTHOLD: Will N511 be any more user-friendly than the N510? We are being asked to comply with N510 but we are saying we use it as a guide.

KLUGE: We hope N511 will be more user-friendly. We are including guidance for development of individual test programs, adapted to facility requirements. Because we are looking at a much larger user group than just the nuclear power plants, we could not mandate a hard and fast test program that everyone must follow. It would not be practical, we would have a document that no one could use. So we addressed the types of tests that should be looked at based on the equipment you have in your own facility. And we have added guidance for developing the necessary level of testing. We are very open for further comments that can be incorporated into the document as it goes through the development stage.

WEIDLER: I would like to get to the bottom line, when these documents are issued, how do they help or change the testing program at McGuire Nuclear Station?

KLUGE: I believe that would depend on whether the individual utility changes its commitment to the new documents. It is not mandatory. I believe it would require a change to Tech. Specs. , if the plant is specifically committed to testing in accordance with N509 and N510. Is that what you are asking?

WEIDLER: That is it. Given the current regulatory climate we still have to do the tests in the Tech. Specs. We would be doing additional tests unless we changed the Tech. Specs., which, as everybody knows, is a fairly lengthy and difficult process.

KLUGE: Under the new improved Tech. Specs., the process is easier because the specific surveillance requirements have been taken out of the body of the Tech. Specs. and put under a filter ventilation test program. This would be like a basis document and it is much easier to make changes in that portion than it was in Tech. Specs. If one adopts improved Tech. Specs., it would be much easier to commit to the new documents with your own level of testing.

GHOST: One of the things that I came across while doing a life extension study was a requirement for housing leak testing every ten years. Most of the plants in the US are over ten years old. 324Does it mean that we have to leak test all the housings?

BURWINKEL: Today, a lot of housings are pressure tested once and never again. We felt this was not adequate to assure that the housings were not leaking. At my site, it has been ten years since we have leak tested housings. We have found a few minor problems, not by testing, but by visual inspections. The subcommittee felt that a pressure test on a filter housing at ten-year intervals was not an unreasonable requirement. It would give us greater confidence that our housings were leak-tight.

GHOST: The older plants are not really set up to do housing leak testing. Is there a basis, besides experience, for ten years? Are we looking at a few plants and saying yes, we did testing on so many plants, and ten years is a realistic basis?

PEST: In other words, is it an arbitrary number that we just selected, or was there some mathematical basis?

BURWINKEL: Ten years was arrived at out of the experience of people on the subcommittee and it seems to have been accepted favorably by the people balloting.

GHOST: Is it possible to make it variable, ten to fifteen years, instead of a finite number? This is a suggestion.

GRAVES: You might prepare expansion of what you are saying and give it to this committee to look at. They will address your comment and get back to you.

GHOST: HEPA filters have a finite life, anywhere from five to fifteen years, by test. Invariably, in-place testing has shown that they are acceptable, but structurally they are weak and they can fail. Have we addressed it by requiring a visual inspection program, to say that even at fifteen years we need to do something prior to testing?

PEST: That would come under the HEPA filter section and filter qualification. If you are performing a visual inspection prior to doing a leak test and notice that the filters have been there for ten years and the glass media appears to be cracking at the base of the units because of high humidity you would want to replace them.

GHOST: That calls for an inspection on a frequency basis?

PEST: Yes, but I do not think we have anything right now that says that after testing a hundred HEPA filters we found that after five years they need to be changed even though the gasket is seal and the media is fine. One of the other committees is looking at HEPA filter aging, and something should coming out about it.

GHOST: Will it be addressed in the TA section?

PEST: It would be addressed in AG-1, I believe.

KOVACH, L: I was involved in coming up with the ten year interval and the way we came up with it was that the proposal was between nine and eleven. So we hired a few statisticians and came up with a reasonable average, that is how we got to ten years. It took several years to resolve and it delayed issuance of the code for some time, but finally we were assured that ten years is reasonable. The reason for retesting housings is not because the structure itself fails, but because of door gaskets and flexible connections deteriorating. Not too long ago I had a chance to walk by a relatively new system. The housing was also used as an air organ, in various places, air was being sucked in at the doors and it was whistling different tunes. The requirement is real. Whether ten years is too long or too short, is certainly subject to question. It relates to how and how often you perform your visual inspections. I have seen systems where the latches float, instead of locking the door; they just hang in the gravity-dictated position rather than in a locked position. It is a question of how to care for the little failures; you do not have to go in for a general repair as often. Certainly 10 years is arbitrary, most requirements are arbitrary, but I believe it is quite reasonable. If anything it may be worthwhile to reduce it. If some old systems do not meet the test requirement, these old systems do not meet their purpose, either. I mean, if they are leaking air, how can we be assured that they are meeting their requirements? Let me comment also on the second question. I do not think that visual inspection alone can tell you that HEPA filters have aged to the point that structurally they may not be able to meet expected pressure, droplet, and thermal challenges. The F sections have to come up with an estimated life for a retest of media strength, etc. I think it is a weak point of the code, at the present time, and it is a weak point of a lot of HEPA filter installations, all over the world, because people assume that as long as the filter passes an in-place test it will perform its intended function in case of an accident challenge.

PORCO: I would like to comment also on the housing leakage issue, and the HEPA filter life issue. AG-1 has a requirement for environmental qualification of safety systems, and that qualification also includes environmental maintenance requirements. For instance, if you are looking at door gaskets when addressing the life of housings, you need to determine the useful environmental life of that component. Using a data base and the Ardenius equation, the gasket life can be predicted. Also, there are requirements on environmental qualification of the HEPA filters that should be addressed. The environmental conditions are going to change for each application. You must address high temperature, you must address all your environmental conditions, address all your materials, and make sure that either the materials last the life of the plant, normal maintenance life, or an environmental maintenance change-out must be established. That is in the standards now. There was environmental qualification on older plants, but possibly the environmental maintenance cycle did not get into the normal plant cycle. I am not sure, but I think that might be where you come up with the ten years. But if you are following your environmental qualification reports, you should be replacing gaskets and other materials before they wear out.

SCRIPSICK: I think the remarks about age are very important. The in-place test, as we perform it, is a snapshot. It tells you what the system is doing that day under normal conditions. It does not provide any information on how the system is going to perform when it is stressed or how it might perform under normal conditions the next day. I see two opportunities to help get some idea of the capability of the components under normal and off-normal conditions. One, is to take some of the filters we have in service now, knowing their exposure histories and their service life histories, and put them back through the qualification test to see how much their performance has degraded compared to the requirements of the design qualification. That is, when you subject them to a heated air test, do they degrade more than three percent or how much is performance changed when you take them up to ten inches of differential pressure. Another opportunity is for careful interpretation of results and, maybe, modification of the tests we are doing. Bergman is going to give a paper tomorrow about the efficiency of filters in-place. I think careful examination of tests like these can provide information about the remaining structural strength of HEPA filter units. As a future development, I think we should look in that direction to garner as much information as we can from the in-place test. One end-point is to try to determine whether the bank we are testing can withstand off-normal conditions.

BATTERSBY: I have a question about retesting existing duct work that has been in service ten years or so. If you do the recommended pressure test would you be in danger of spreading contamination through any leaks that may exist from duct work up stream of the filter bank? Perhaps the retest should be done under negative pressure, rather than positive.

LEONARD: Normally, leak tests are performed on a system in the pressure mode in which they operate, a negative pressure system would be subjected to negative pressure tests. Positive pressure systems (I can't think of any that operate that way) would be the only ones that would be tested under positive pressure. It would require a careful survey by the radiation control people and the whole HVAC engineering group to verify that it would not spread contamination. One thing that the committee looked at, and the basis, I think, for the ten year test interval, was the experience of people on the committee looking at systems in the plants that have been in operation for five, ten, fifteen years. When you look at a system after five years, it does not take a rocket scientist to determine that it is not in the same condition that it was when it was installed and tested.

BERGMAN: I want to add to some comments that Ron Scripsick made about aging. Last conference, John Fretthold, Humphrey Gilbert, and I presented a paper on aging effects of HEPA filters. We searched manufacturers and facilities around the US and attempted to do an aging study. We found that, after ten years, a filter has about half the strength it had initially and it has no water repellency left, things of that nature. We found from some manufacturers basically brand new filters that had strengths that were a fraction of some of the filters that were over ten years old. Through a laboratory analysis we found out there was insufficient binder in the medium to hold the fibers together, and that these filters were practically falling apart. Instead of worrying about setting age limits, let's take a real hard look at the test standards we have. I would like to put in a plug in for Dr. Ricketts' paper, later on this week, about qualification tests. I am not an expert on QA, but to me any QA system that is based on a manufacturer hand picking the best filters to bring them to a qualification test every five years, with no checks in between, is insanity. To expect any reliability under this kind of procedure is nuts. All you have to do is refer to our paper from the last Air Cleaning Conference to see the insanity of the present qualification program.

PEST: The rest of this panel session will be on testing air and gas treatment systems. We have the floor open for questions to the panel on any of the topics of the N511 in-service testing document, and Section TA on acceptance testing, from the AG-1 Code.

How much benefit do you think a utility or a nuclear facility owner would get by moving to AG-1 and N511 as opposed to remaining with N509 and N510? I am trying to learn if there is any benefit as far as clarity goes, because regulatory officials rely on the Regulatory Guide 1.52 that cites ANSI N510-1975 and N509-1976. Since 1976 there have been many changes, yet the Regulatory Guide fails to reflect them. Do you think that moving to N511 will cause the NRC to re-evaluate their position?

GRAVES: For a utility to move to any of these documents from N509 and N510 involves technical, political, and financial considerations. A lot of the N509 built equipment is already difficult to test by N510 methods and it might be that a more particular TA or N511 would cause more problems and people might resist changing. I think TA and N511 will be more particular and more helpful, but there will be less margin, less wiggle room, about what should or shouldn't be done. If the equipment is marginal, these documents are not going to be well received. But they ought to be evaluated as best for equipment. It is going to end up being a political and economic question, I think. We encourage everyone to look at these documents, because they are going to be a lot more helpful and there will be less chance to miss something important in testing and operability of equipment.

LEONARD: I think that they would be better off because they would have a better integrated package than they now have with N509 and N510. I think the package is tied together better. As Curt pointed out, they supplement one another better than N509 and N510 do now.

PEST: Does the panel think that N511 may, in the future, be expanded with an appendix to address the testing of portable filtration systems? I would like to get some guidance because there is not very much available on portable HEPA filters. Do you think some clarification should be made in N511?

KLUGE: N511 is currently set up just to look at permanently installed systems that are designed according to AG-1 requirements. It would be possible to have a non-mandatory appendix that gives guidance on testing such systems. I do not know how much demand there would be for it, or if it would be better to put out some other kind of guidance document specifically addressing those types of systems.

GRAVES: In the absence of a well-designed fabrication document for that equipment, folks could probably use some guidance. Hard and fast testing requirements are not going to help the manufacturers of portables and vacuum cleaners because there is such a variety of equipment out there. Some suggestions might be in order, but hard and fast rules are going to be a problem for them.

KRANZ: I am going to change gears here and start talking about adsorber testing, in-place leak testing. As of January 1, 1997 Freon will not be allowed into our facility. My question to the panel and the audience is, what challenge gases are people using now? What challenge gases are people looking to use? I did not notice in N511 specific challenge gases mentioned. Did I miss it?

PEST: I believe it is in there.

KLUGE: There is an appendix in both TA and N511 which spells out the critical characteristics that have to be met for an alternative challenge agent. But no specific agents are mentioned by name in those documents.

KRANZ: What are people using or looking at using? We are between a rock and a hard place if our facilities are not going to allow us R11 in 1997. The bottom line is, if we use a different challenge gas, will the tests be accepted by the NRC?

GRAVES: Some people are using HCFC123. At the last Air Cleaning Conference, Bela Kovach, of our organization, gave a paper on it. Some are using a compound called 1-Bromo butane. I do not know if it will be widely accepted in the nuclear business, but HCFC123 looks like a good candidate that meets the list of criteria in appendix TA-C. It is always risky to speak for the NRC (there are representatives here who can do that) but my understanding is that when the industry standards people recognize a compound, it is acceptable as far as the NRC is concerned. When N510 is the required, or appropriate, standard, whatever N510 says is okay with the NRC.

LEONARD: The appendix that is in TA and N511 was the basis for a code question response on N510. So it is applicable to N510, also.

HAYES: The guide for any facility is their technical specifications. If you have a problem you need to request a Tech. Spec. change and give the basis for the change. As many of you know, we had a problem with verbatim compliance with the test methods for laboratory testing of charcoal. So it is imperative that we determine what your technical specifications say. If they require you to test a particular way and there is no flexibility, then you need a technical specification change.

FIRST: Further to this same discussion, I am a member of the committee and urged that certain compounds be named as those that have been found acceptable, without indicating that they are the only ones that could be used. Certainly, the criteria that have been published clearly define the characteristics. But few people are able to make this judgement on their own or have the facilities to do so. It seems to me that the standard should provide some guidance in terms of acceptable compounds as examples of what will work. I hope that change can be made, because I, among others, get calls from people wanting to know what is a representative compound that they can use. I do not see why we make a mystery out of it. I want to ask the panel a question. We hear a great deal about international standards and how the international standards organization operates. Having documents approved as international standards is often discussed by code and standard writing committees. Variations of our codes and standards have been adopted by other countries. How can we go about making U.S. standards international standards? And is this highly desirable?

WEIDLER: It is my understanding from ASME that if it can be shown that our standard is being used in countries other than the United States, they are designated international standards. ASME itself is now called ASME International and their boiler code is used in countries other than the US.

PORCO: The code section you have prepared addresses primarily systems for commercial nuclear power plants. Did you take into consideration other systems used at DOE sites and military installations, and can they be easily adapted for those systems?

LEONARD: Insofar as we had input from those sites, we did try to make the document broad enough to cover them. We have representation from DOE on the testing subgroup and subcommittee. We hope we have managed it.

PEST: Yes, we do try to make the code and standard all-inclusive and not be tied down to a specific function.

SCRIPSICK: I have just tracked the history of these standards for my office. The '75, '76 and '80 versions of N509 and N510 were for "nuclear facilities." There was a change in '89, they were now for "nuclear power facilities." This was a change in scope. Now, I am not certain what AG-1 says. It looks like it has been broadened to include all nuclear facilities.

PEST: That is true. There has been some switching around of names, and we try to emphasize that the documents can go across barriers. It might even work out that they can be used in the general commercial area, not just nuclear facilities.

KLUGE: I would like to add that the current scope statement for both Section TA and N511 refers to nuclear facilities, and not specifically to nuclear power facilities.

SCRIPSICK: The speaker was very careful to point out that TA is a code and N511 is a standard. The difference is that one is for acceptance testing, and the other for in-service testing. Why is in-service testing a standard? Is a standard a lesser requirement than a code, or a law? Why was the distinction made?

PEST: When we took all the in-service testing material out of Section TA, and began composing N511, the first thing that we did was to change all the "shall"s that we could, and make them "should"s since a standard is better cast in a more generic overview of what is going on. However, you have to remember that it is the facility's design basis that really dictates what you have to do in the testing. Technical Specifications are spelled out.

KLUGE: The original draft of Section TA addressed both acceptance testing and in-service testing. However when that got up to the level of the BNCS we had to separate acceptance testing from surveillance testing. I do not know what was involved behind it, but that is where the split took place.

GRAVES: Part of the requirement was to make the documents more user-friendly. A document covering both was very confusing. This makes it much simpler.

PEST: I do not know whether I agree. I think Section TA could have handled both rather than make a whole new document. But I am glad that we didn't have to undertake a massive reconstruction of N510.

WEIDLER: One of the driving forces behind the Board's decision to split TA into two documents is that in-service testing is in one section of the code and acceptance testing is in another. In order to follow the format guidelines that ASME has adopted for the overall code, we had to split the TA draft into two different documents.

GHOSH: In the last sentence of section 8.10 in N511 it says that the integrated system test should be once every two years. Under the sub-heading you have air system flow balance verification tests. Is it implied that the flow balance is being tested every two years?

KLUGE: We have had some heated discussions at the committee level on that particular subject. The document will not require a full-blown air balance, such as would be done at start-up. Guidance will be developed that will allow the user to verify system balance by looking at the end functions. For example, if temperature is the critical function, temperature surveys will serve to verify a balanced condition. If pressure is the critical function, non-ducted airflow testing could be utilized. Guidance will be provided, and there will not be a requirement for a full re-balancing of the system.

GHOSH: Will that section be expanded?

KLUGE: That section will be revised, and there will probably be a non-mandatory appendix that will give detailed guidance.

DEVENA: Section 8.6 of N511 covers hydraulics. This is in somewhat the same light as the previous question, are we looking at a complete flow balance of the water systems? To what depth do we go with that? Originally, the whole system was aligned and balanced in the emergency flow mode, quite exhausting and quite extensive. I am not sure that you could come up with the same type of conditions by looking at individual components within the water system. If this is going to be a requirement, I think it goes far beyond just a component that will be looking at water balance. It is like a whole ESW system. You change the flow one place and you might not be able to get it at the other place unless it is lined up like it normally is for the emergency flow condition.

KLUGE: I think we will need additional guidance on the level of hydraulic balance within the document. The bottom line is, can you meet your design basis for heat rejection? If you are never doing any kind of verification of what your flows are, there has to be some kind of test data you can look at to see if you can meet your design basis. Also in Table 8-5, there is a two-year requirement for a cooling coil performance test. I believe the two years came from a recommendation by the maintenance rule that everything seems to go on a twenty-four month cycle. The maintenance rule that became law on the 9th of July will directly affect this type of testing. That is where the twenty-four month recommendation came from.

KRANZ: Did you say N509 and N510 are going to be reissued?

PEST: They have been reaffirmed.

PORCO: ASME N510 has been reaffirmed. When you receive your copy from ASME it will have the reaffirmation sticker. N509 has not been formally issued as reaffirmed, but it will be shortly.

SCRIPSICK: What is the distinction in TA and N511 about test requirements being observed or measured? What is the distinction? Maybe it is defined in sections of AG-1. Why is the acceptance test for HEPA filters a measurement requirement, whereas the in-service test is an observation requirement with a two-year period?

KLUGE: You made a good catch, that is a measured requirement.

SCRIPSICK: So there is a mistake in Table 8-6?

KLUGE: Yes.

SCRIPSICK: What is the distinction between measured and observed? I do not understand how they contrast.

KLUGE: The distinction between observed and measured is that a visual inspection is observed whereas anything that has a definite acceptance value would be a measured test.

GHOST: Previously, the requirement for personnel qualification was to be certified according to ANSI 45.2. Now you have NQA-1 and ANS standard 93.1. Is there a reason for not including 45.2?

KLUGE: The qualification criteria in this section came directly from section AA of the AG-1 code.

PEST: ANSI 45.2 is an old document, I am not sure it is still valid.

KLUGE: The specific wording is from Section AA 7220 regarding personnel qualifications. It states that all personnel performing on-site inspections and testing of AG-1 equipment shall be qualified in accordance with ANSI-ASME NQA1-1, supplements 2S-1 and 2S-2. So we just brought down the personnel qualification requirements from the code.

PEST: Is NQA-1 as stringent as N45.2?

GRAVES: I think they are about the same.

ORZECHOWSKI: Your scope is changed to include all nuclear facilities. What is your definition of nuclear facilities?

GRAVES: I think we mean any place that has fissionable material. We define nuclear facility as any facility that operates under radiological conditions. I imagine that would encompass just about all facilities that are licensed. We mean this for nuclear power plants, plutonium facilities, waste handling facilities, or any facility like that has air cleaning equipment, or the need for air cleaning equipment. We hope the standard will address the kinds of needs they all have. I do not know what guidance BNCS or ASME gave on this, so we may have weasel-worded it a little bit by using the term nuclear facility.

ORZECHOWSKI: I am working at the Nordion facility where we produce radio isotopes using an accelerator. Are we a nuclear facility? What do we base this on, how can we define ourselves? Going even further, I can ask whether nuclear medicine departments in hospitals are nuclear facilities. Now you are shifting from a very specific application to power plants to all nuclear facilities. There has to be some definition of what is covered. I do not know that such a definition exists. If you rely on the issuance of a license, hospitals have a license, but are they nuclear facilities? I do not know.

GRAVES: That is a good point. You could say, yes, they are, because they are regulated by NRC and follow other requirements. They would be welcome to use this document. It might not do them much good because they may be covered elsewhere. The regulating bodies may dictate to them something that precludes their use of the AG-1 code. But there is no reason why, for any given application, the AG-1 code could not be used. There is nothing to rule it out as applicable to that kind of facility. If there is a chance of airborne contamination, this code would apply, or it could apply.

PYLE: What is the intention for the air/aerosol mixing test procedure when you have a small facility where you might have a single HEPA filter as a HEPA filter bank? Would it be applied to a single

GRAVES: I am on the ventilation air cleaning committee, and may disagree with others. I think there should be some evaluation of air/aerosol uniformity, even for a single HEPA filter. That is an opinion that may not reflect what the TA group would say.

LEONARD: In a change from N510, where single HEPA filter systems are exempt, the exemption has been taken away in TA and N511.

PYLE: Therefore, you are saying it would apply?

PEST: You would have to make an air/aerosol mixing uniformity test for a single HEPA filter. Due to system configuration, the distribution may not be uniform and that would necessitate performing the test.

PYLE: Self-contained units would probably fail this test. Is this correct?

LEONARD: Yes, they almost surely will fail.

ANON: There is action in the committees to designate another category for this type of filter. And removing the exemption in N510 makes it necessary to address this issue. I think we are going to let the filter committee see if it warrants bringing out a new classification of filters.

SCRIPSICK: I agree with Curt Graves that there should be testing requirements for acceptance of single-filter systems. Some are being accepted by exemption because the procedures for air/aerosol mixing and for air flow distribution for filter banks at the center of each filter requires a measurement . Therefore, when you have only one filter you just take one measurement, even though that procedure does not apply. If we eliminate the single-filter exemption, we will have to make allowances in the procedure. I propose that we look at it.

BURWINKEL: Currently TA has a requirement for a minimum of nine readings, with the exemption for testing a single filter removed. It would require you to take nine readings in front of a single filter.

LEONARD: That is in mandatory Appendix 4, Section 4-4000.

DEVENA: Prior in-service testing documents contain a distinction between air cleaning equipment totally contained inside a containment, where it does not exhaust to the atmosphere. Does this new document allow the same exemption for filtration systems inside containment?

PEST: You mean, exempt from in-place testing?

DEVENA: Yes.

GRAVES: Are you talking about a Tech. Spec. issue? If your Tech. Spec. does not require it, you do not need to do it. These documents are not intended to supersede your Tech. Specs., just help to test, design, and manufacture equipment. If you are not required in your Tech. Spec. to test them, you could still use this document, but you might use it in a somewhat different way, and you might establish acceptance criteria that would be a little bit different.

DEVENA: Our Tech. Specs. presently reference R.G.1.52, which references the two ANSI standards where you get the exemption on units that are totally enclosed inside the containment. It is not specifically the Tech. Spec. that addresses it, it refers to it by reference. The same exemption is not referenced in the new documents.

BURWINKEL: If your system is entirely inside a containment, is it safety related?

DEVENA: No.

BURWINKEL: These documents refer to safety-related systems. Because we did not find any examples where there was a safety-related system fully contained inside containment, we did not see any reason to carry that provision forward.

KLUGE: In Table 8-7, in the current version of N511, there is the caveat that in-place leak tests are not required for systems used for 100% re-circulation. An example is a reactor containment clean-up system. That is why the exemption is in N511.

GRAVES: N511 is directed to once-through types of equipment.

KLUGE: I would like to encourage everyone to take home the copy of the N511 document, read it over, and provide us with feedback so we can make it an industry-useful document.

GRAVES: Does TA go back to the Main Committee after addressing negatives?

PEST: Yes. Section TA will be ready to go to the Main Committee by August 2. We are looking to October to get the results. If the Main Committee approves, it will go to the BNCS. I do not know how long the BNCS usually takes to make a decision. Last time it was pretty fast.

This Panel Session was an opportunity for our Committee to let you have a look at these documents. We got some very interesting comments and questions which we appreciate. We are looking for your support and contributions to make these documents user-friendly and to provide the help you and your neighbors need.

SESSION 5

WORKING LUNCH
Tuesday July 16, 1996

Co-Chairmen: M.W. First
J.L. Kovach

Invited Speaker: **John D. Wagoner**, Manager
Department of Energy, Richland

PROGRESS AND CHALLENGES IN CLEANING UP HANFORD
J.D. Wagoner

INTRODUCTION

FIRST: On my extreme left is Lou Kovach of NUCON International. You have heard from him previously during this conference, I think most of you know him. I mentioned yesterday morning that he has been very intensively involved in certain of Hanford's innovative operations. Because he has been so intimately involved in Hanford for the past couple of years, I thought it would be appropriate if he would introduce our luncheon speaker.

KOVACH, L: Ladies and gentlemen, I have a Department of Energy biography on John Wagoner, but I would like to start off by ignoring it for a minute and just tell you that I have seen John facing pronuclear civilians, antinuclear civilians, Native American tribe representatives, and then some people even worse, technical staff at Hanford, some of the contractors, National Laboratory representatives, headquarters people, and common folks like us. And there were always a lot of people who were trying to complain about something that the Department of Energy was doing at Hanford. And he always managed very graciously to field the questions and not get mad. And, really, what I admire about him the most is keeping cool in talking about things that sometimes are totally off the wall, and sometimes highly technical. And I know that I could not do that. I'm sure most of you are aware of my temperament. But John has been manager of the US Department of Energy's Richland Operations Office since July of 1990. He is responsible for the Department's mission at the 560 square mile Hanford Site reservation. The Hanford mission is to clean up the environmental legacy from the defense production of the cold and the warm wars of the past. He has worked on many different activities, starting with the Schenectady Naval Reactor's Office through various projects at Oak Ridge. At one time, it looked like, he had managed to escape the nuclear business for a while, and he was project manager for the strategic petroleum reserve. I am sure, John, you think back to those days as more peaceful than some of the nuclear activities. He was deputy manager of the Savannah River Operations Office and worked in the US Navy supply corps. Again, I am not sure if he is happy that he made the decision, but he resigned his lieutenant commander's commission in '71 to accept a civilian appointment at the AEC. In 1983 John got the Secretary of Energy's meritorial service award, and received superior performance awards from the Secretary of Energy in 1990 and 1991. He is from my neighbor state, (not from Serbia or Austria), Indiana and is a good boilermaker from Purdue University. It is a pleasure for me to introduce John D. Wagoner.

WAGONER: Thank you very much. This is a special privilege for me. This is the first Nuclear Air Cleaning Conference I have ever addressed. My talk will not be about nuclear air cleaning, but maybe you will see some parallels and some areas of interest, as we go talk about what I like to talk about, which is the Hanford Project, or Project Hanford, as we are now calling it. The talk that I'll give today will try to get across a few simple key points. I will describe, of course, what the job is that we are doing at Hanford. And those of you who are working there either all the time or part of the time, I hope you will bear with me if it is redundant with what you already know. The message that I want to get across about that is that the job is getting done. One of the other important parts of it is most of it, I believe, will be complete within ten years. And in order to complete that ten-year vision, we have an awful lot of very difficult problems to resolve. I am sure that a number of you can contribute to doing that. So we'll start with the next slide to try to put things in perspective. I understand that a few of you have signed up for a Hanford site tour, I certainly encourage you to do that. One of the things I believe we have been able to do to better communicate with the public is to make the site accessible.

24th DOE/NRC Nuclear Air Cleaning and Treatment Conference

Environmental Excellence

HANFORD

John D. Wagoner, Manager
Richland Operations Office
U.S. Department of Energy

July 16, 1996

Progress and Challenges in Cleaning Up Hanford

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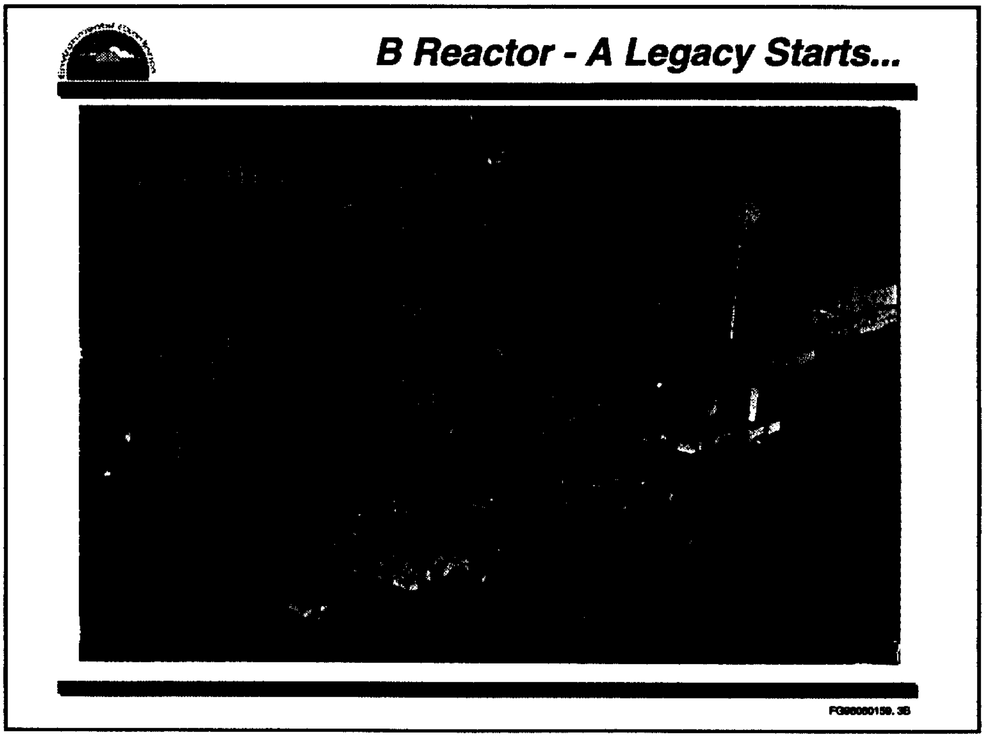
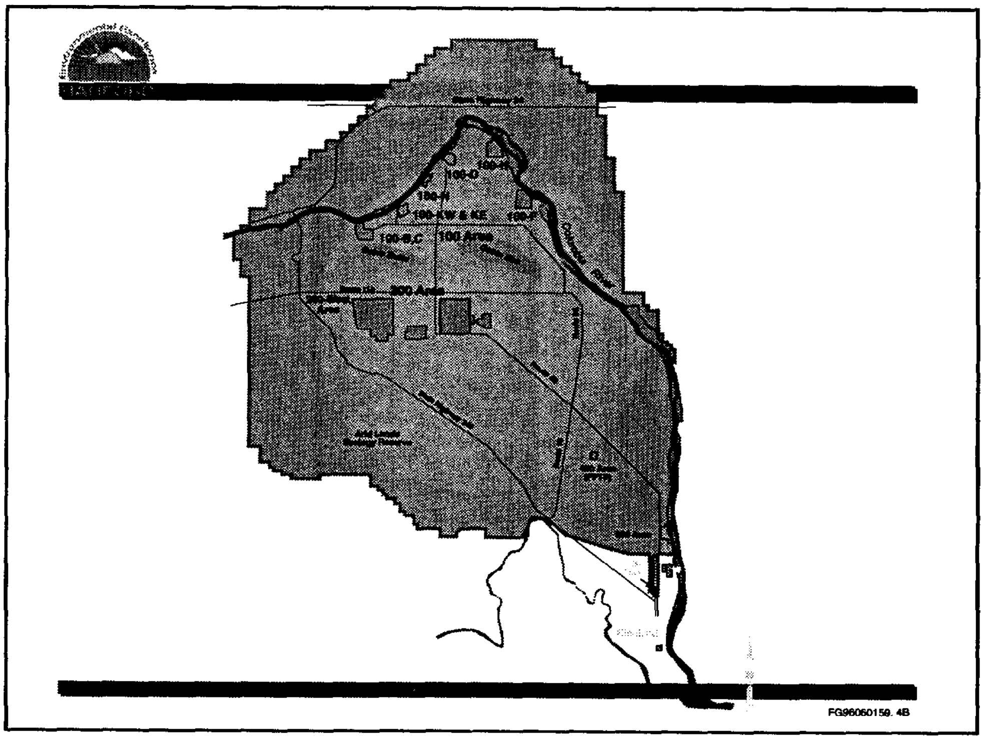
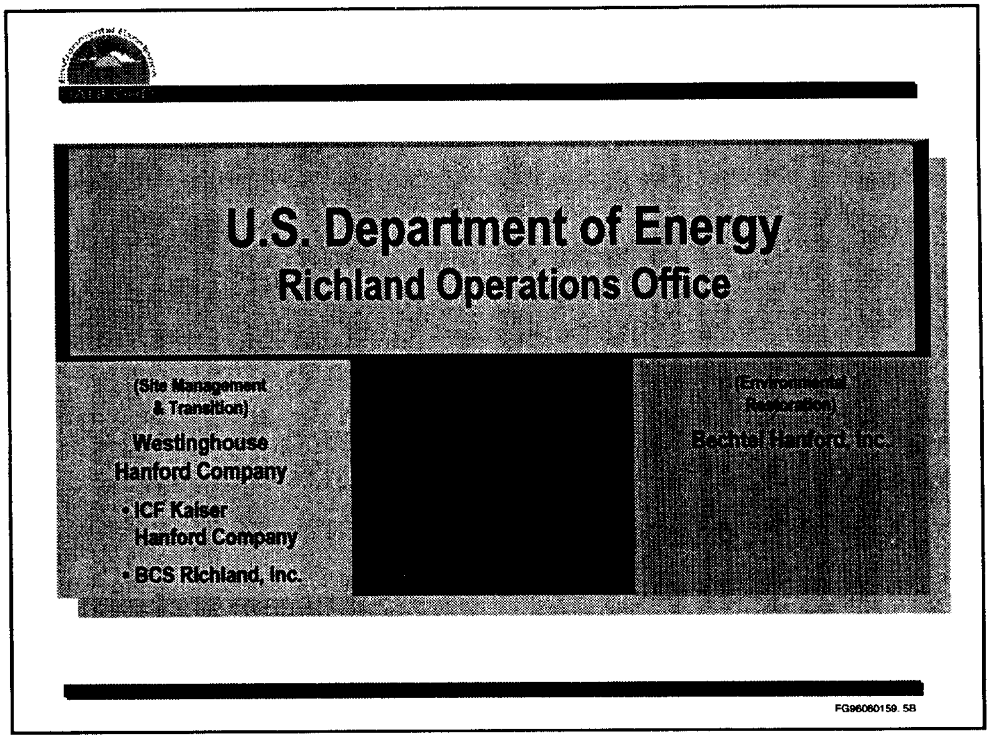
Hanford was established in secrecy during the Second World War to produce plutonium for America's nuclear weapons. Peak production years were reached in the 1960's when 9 production reactors were in operation at the Site. All weapons material production was halted in the late 1980s and the Site is now engaged in the world's largest environmental cleanup project.



The famous `B' Reactor along the Columbia River on the Hanford site where plutonium was produced for the Atomic bomb dropped on Nagasaki, Japan. The world's first nuclear reactor, it was constructed and operational within 14 months in 1944.



Approximately half the size of the state of Rhode Island, the 560 square mile Hanford Nuclear Reservation played a key role in bringing World War II to a close. In decades to follow through 1989, during the Cold War, Hanford produced most of the nation's plutonium for defense purposes. The year 1989 marked a turning point in the Hanford's mission from defense production to environmental cleanup.



Today our cleanup challenge is managed by Westinghouse Hanford Corporation and its subcontractors. A site wide environmental restoration project is managed separately by Bechtel Hanford, Inc. Supporting both Westinghouse and Bechtel, as well as DOE nationwide programs, is the Pacific Northwest National Laboratory with scientific research and technology development.

Progress...

Our Priorities...

- Urgent Risks
  - Tanks
  - Spent Fuel
  - Plutonium
- Mortgages
  - PUXEX
  - B-Plant / WESF
  - FFTF
- Waste Management
- Environmental Restoration

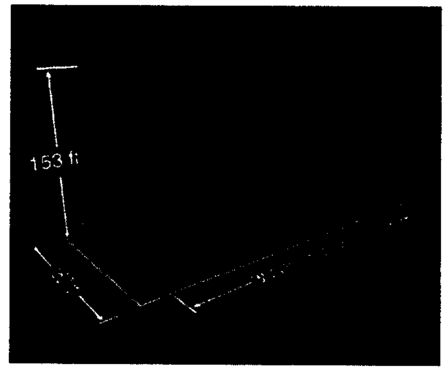
The U.S. Department of Energy and its contractors have tackled the environmental cleanup challenge within the framework of set priorities.

Progress...Urgent Risks

Tanks

177 Underground Waste Tanks

- **55 MGals High Level Waste**
- **67 Single Shell Tanks Leaked or Suspect**
- **Cross Site Transfer Line (West Tanks to East Tanks)**
  - **Remove Liquids From Single Shell Tanks**
  - **Consolidate Waste For Vitrification**
- **Evaporator Campaigns Reduced Waste by 8 1/2 MGals**



- **Award Contracts for Treatment of Tank Waste (Vitrification)**

FG96080159.7B

Formidable challenges in our underground waste storage tanks cleanup effort are being met with innovative approaches and technology. With the construction of a cross-site transfer line we will be able to remove liquids from tanks known to leak to more reliable double-shell tanks.

Additionally, our `Evaporator Campaigns' have freed-up additional space to receive waste, thereby saving $600 million in otherwise needed new tank construction. Since 1994 eight million gallons of liquids have been evaporated.

Progress...Urgent Risks

Spent Nuclear Fuel

An Urgent Risk on the Columbia River

- **Fuel Corrosion Continues**
- **K Basins 20 Beyond Design Life (recent leakage in 1993)**
- **Seismic barriers in Place**
  - **Mitigate Leakage**
- **Canister Storage Building Design Complete**
  - **Construction Started**
  - **Fuel Transfer 12/97**

2,100 MT/53.8 MCi
105,000 Elements

FG96060159.8B

Based in part on advice from our stakeholders, we have identified spent fuel stored in basins near the Columbia River as a priority project to reduce urgent risks at Hanford. The basins in which the 2100 tons of spent fuel reside are 20 beyond their design life and one has a history of leakage of some 15 million gallons.

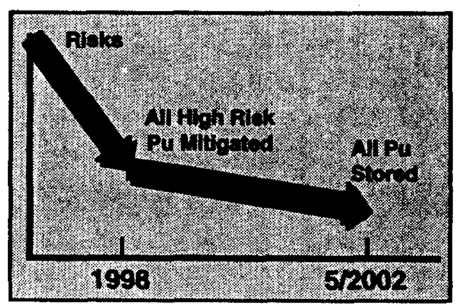
In a very creative way DOE and its contractors have come up with an accelerated plan to remove the spent fuel from the basins and place it in dry storage on the central plateau. One creative way we were able to speed up the project was by using an existing foundation for a cancelled project for the new Canister Storage Building needed to house the spent fuel rods when they are removed from the basins.

Meanwhile we have mitigated the leakage problem with the installation of seismic barriers.

Progress...Urgent Risks

Plutonium Finishing Plant

- 3.9 Metric Tons of 11 Tons Site Total
- Completed Stabilization EIS
- Issued Record of Decision
- Developed Solutions Stabilization Process
- Complete Stabilization of All Other High-Risk Materials



FG96060159.9B

We have made significant progress in deactivating this facility. We have completed the plutonium stabilization EIS, issued a Record of Decision, and began a stabilization campaign for all high-risk materials in the facility which will stabilize liquids in FY98 and all material by 2002.

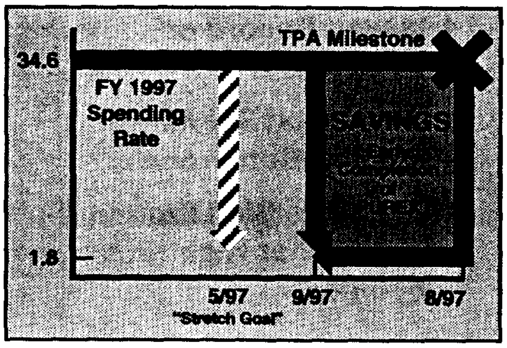
This puts us in a position to mitigate plutonium risks at PFP in 1998 and have all plutonium stored by 2002.

Progress...Mortgages

PUREX

Plutonium URanium EXtraction

- **Major hazards disposition/stabilization**
  - **Pu/U solutions (6,000 Gals)**
  - **Organic solvents (21,000 Gals.)**
  - **Nitric acid (187,000 Gals.)**
  - **Residual Pu Qxides (Glove Box)**



At PUREX we have successfully removed major hazards from the facility in preparation for proceeding with final decontamination and decommissioning. Among the materials dispositioned are: 6,000 gallons of plutonium/uranium solutions; 21,000 gallons of organic solvents, 187,000 gallons of slightly contaminated nitric acid; and residual plutonium oxides from glove boxes.

Progress...Mortgages

B-Plant / WESF *(Waste Encapsulation Storage Facility)*

- **Retrieve remaining Cesium from Private Facilities**
- **Plan for FY 1998 B-Plant Deactivation "Breakthrough"**

B-Plant 1 MCi
WESF Capsules 149 MCi

FG96060159.11B

We successfully recovered 25 cesium capsules from a commercial facility in Virginia thus completing the recall of more than 700 capsules which had been leased to commercial companies.

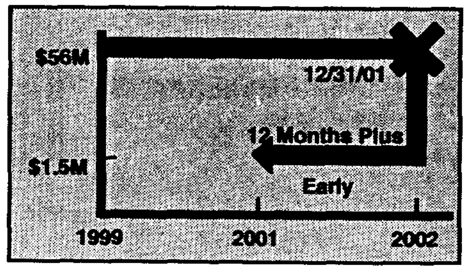
Work on decoupling WESF and B-Plant continued at an aggressive pace and we are poised for a "breakthrough" in B-Plant Deactivation in FY 1998.

Progress...Mortgages

FFTF

Fast Flux Test Facility

- **Transition: Operational to Safe Shut Down Condition**
  - **375 Fuel Rod Assemblies**
  - **260,000 gallons of liquid sodium (coolant)**
- **63 Fuel Assemblies processed to Interim Dry Storage (Complete in 2001)**
- **Preparing Sodium Storage Facility (4 Tanks) - October '96**



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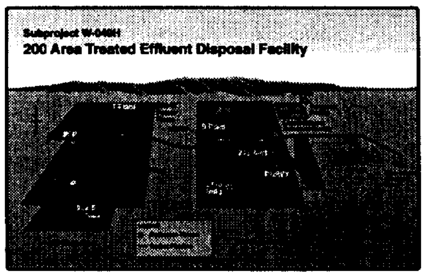
The FFTF continues to be transitioned to a safe shutdown condition in preparation for final decommissioning and decontamination. Work that is not irreversible, such as fuel washing, continues as we await the Secretary of Energy's decision as to whether of not FFTF will be considered as a tritium producer.

Progress... Waste Management

Waste Management

- Billions of Liters Untreated Liquid Wastes to Soil (Over 45 Yrs - 200 sq.mi. contaminated groundwater)
- 300 Area Treated Effluent Disposal Facility (TEDF)
  - Discharge clean water to Columbia River (Standard 1000 times more stringent than City's)
- 200 Area Effluent Treatment Facility
  - National Pollution Discharge Permit (ID'd as one of nation's most stringent)
- Ceased discharge of all liquid effluents to groundwater - 6/95



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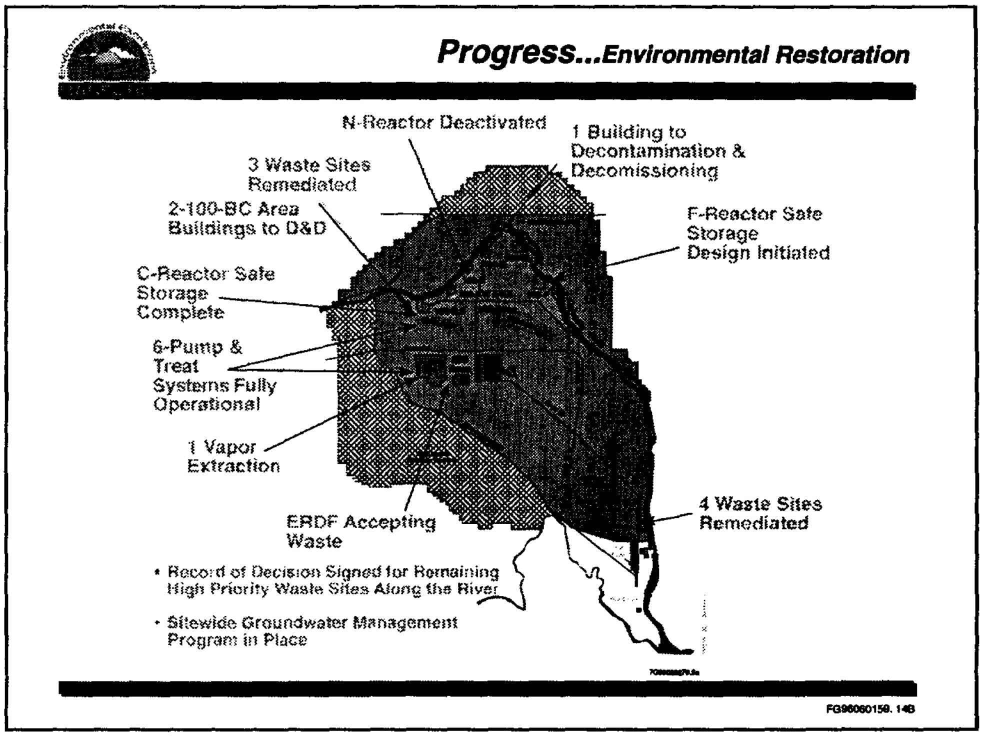
Exceptional progress has been achieved in the treatment of liquid effluents at Hanford. We brought on line the 300 Area Treated Effluent Disposal Facility and 200 Area Effluent Treatment Facility.

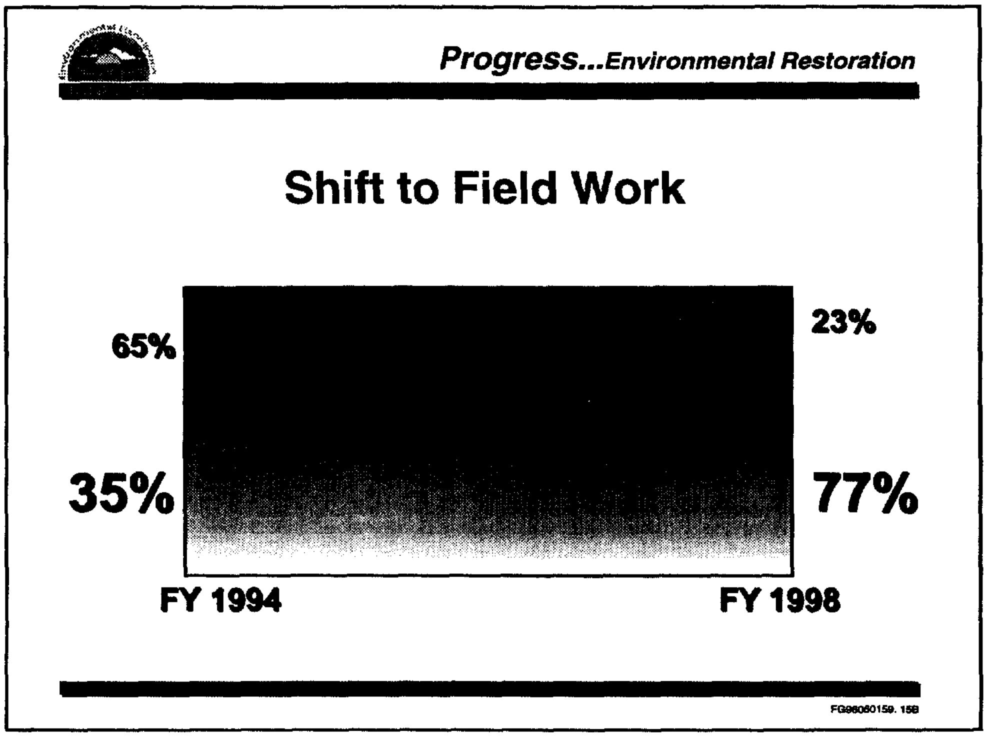
We ceased all unpermitted discharge of effluents to groundwater in June, 1995.

Our discharges to the Columbia River from the 300 Area meet standards 1,000 times more stringent than city requirements.

Our National Pollution Discharge Permit is one of the most stringent in the nation.



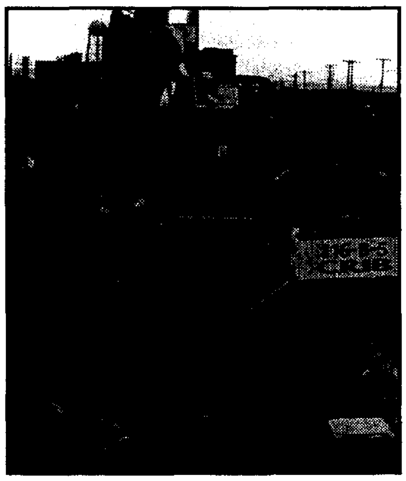
BHI, our Environmental Restoration contractor, is responsible for cleanup of groundwater, contaminated soils, and inactive nuclear facilities. A major focus of the ER program is protecting the Columbia River by cleaning up contamination along a 20-mile stretch of land along the river where nine nuclear reactors are located.



Since the start of ER cleanup activities in July, 1994, cleanup dollars expenditures have shifted from 65% paperwork to 77% actual field work.

Progress...Environmental Restoration

Waste Sites Remediated

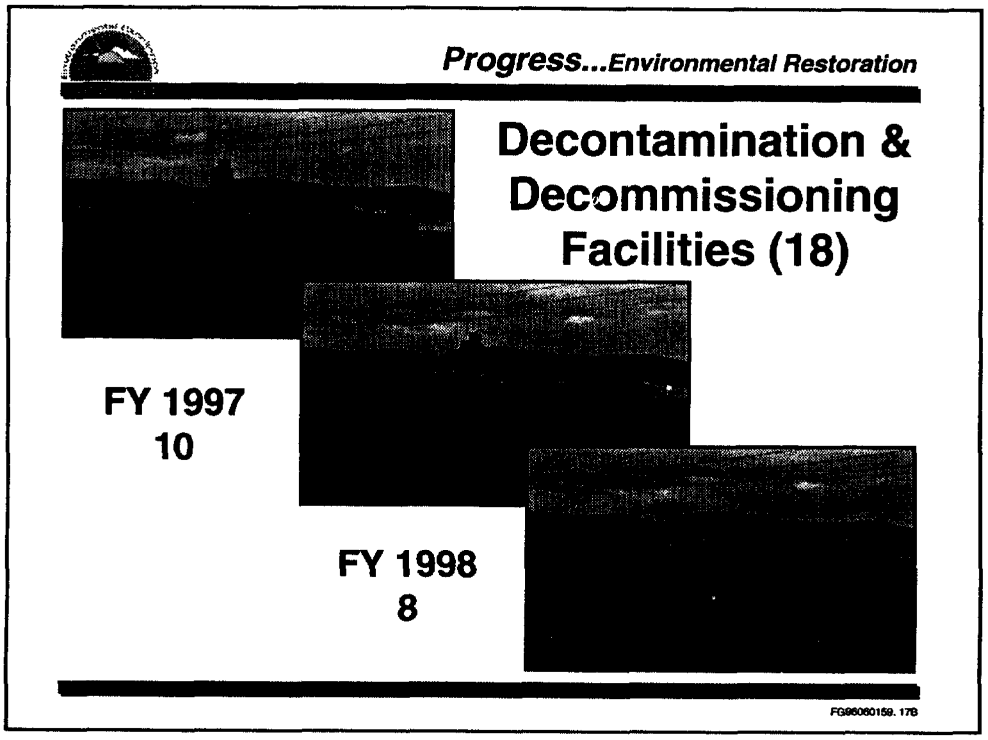


- **FY 1997 - 10**
- **FY 1998 - 12**

22

FG96060159.16B

And with more dollars spent on cleanup, we see an increase in progress of actual waste sites remediated. Uncovered cribs and trenches and other waste sites along the Columbia River have produced 37,000 tons of contaminated soils and materials.



Removing Hanford's aging surplus nuclear facilities is the ultimate goal of the D & D program. Here we see the demolition of the 190-D Pump House remaining framework after decontamination.

Progress...Environmental Restoration

Groundwater Plumes Treated

	FY 1997	Through FY 1998
Plumes Treated	5	5
Gallons Pumped	360M	760M
Carbon Tetrachloride (Pounds) Removed	180K	200K

Containing and preventing the spread of contaminated groundwater, while removing contaminants from aquifers, are major objectives of the ER Groundwater Remediation project. In 1996 the project pumped and treated 83 million gallons of groundwater and removed 159,000 lbs. Of carbon tetrachloride by vapor extraction.

Progress...Environmental Restoration

Environmental Restoration Disposal Facility Accepting Waste July, 1996

FG96060159. 19B

Designed to receive low level waste from site cleanup projects, ERDF is operating 3 months ahead of schedule and roughly $80 million under budget. These first two `cells' of a possible 12 can safely hold 1.2 million cubic yards of material, equivalent in size to 95 Goodyear blimps.

Progress...Environmental Restoration

N Reactor Deactivated FY 1997

- 67 ancillary facilities also deactivated
- N Basin cleaned

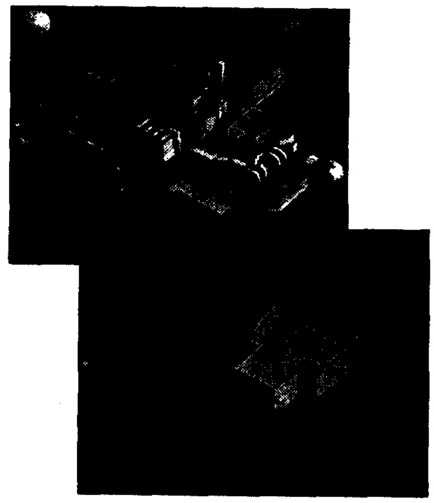
FG96060159.20B

Deactivation of the `N' Reactor and its supporting facilities is in the DOE spotlight. This effort presents a challenge as to how similar work will be conducted at other DOE weapons sites.

Progress...Environmental Restoration

C Reactor Safe Interim Storage FY 1998

- **Long Term Safe Storage**
  - **Low Risk**
  - **No Maintenance**
- **Demonstration Platform for Technology Transfer**



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Placing the 'C' Reactor's core in an Interim Safe Storage mode for up to 75 years, pending final disposition, is a DOE pilot project that will demonstrate 19 technologies in the process. The concept and successfully demonstrated technologies may be duplicated at other sites.

Challenges...

- ***"My primary goal in managing this program is to reduce most of the risks and most of the mortgages over a ten-year period... Most important, we need to move this program toward completion... We have an opportunity to show that a ten-year effort to reduce risks and mortgage costs can substantially reduce obligations and risk on future generations."***

  Al Alm, Assistant Secretary
  Environmental Management
  U.S. Department of Energy
  (From All Employee Message, May 10th, 1996)

- **Hanford Vision 2006: Safe Interim Status**

FG96060159.22B

Mr. Al Alm, our new Assistant Secretary for Environmental Management, has presented a challenge to all DOE sites. Within the next 10 years, a majority of cleanup projects throughout the DOE complex is to be completed. D & D, soil remediation, and groundwater cleanup are targeted categories for this deadline.

Challenges...

ongoing/daily...

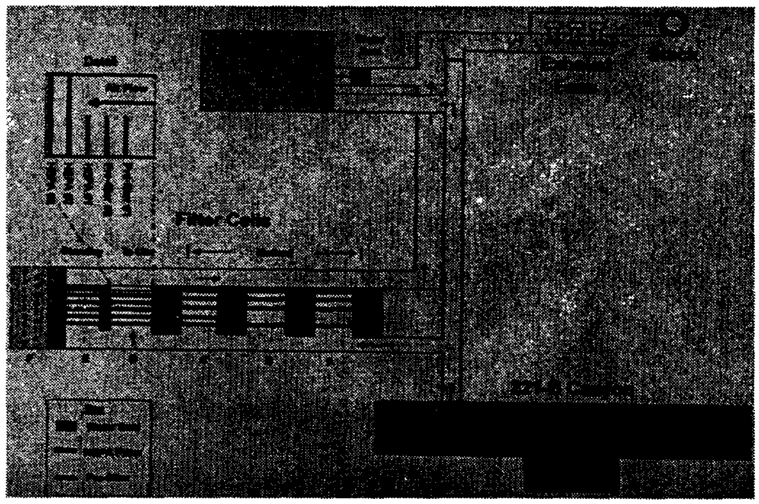
- **Worker and public safety**
- **Waste Management**
  - **Storage**
  - **Disposal**
  - **Transportation**
- **Budget uncertainties**
- **Tri-Party Agreement**
  - **Commitments**
  - **Working with Stakeholders/ Regulators**

FG98080159.23B

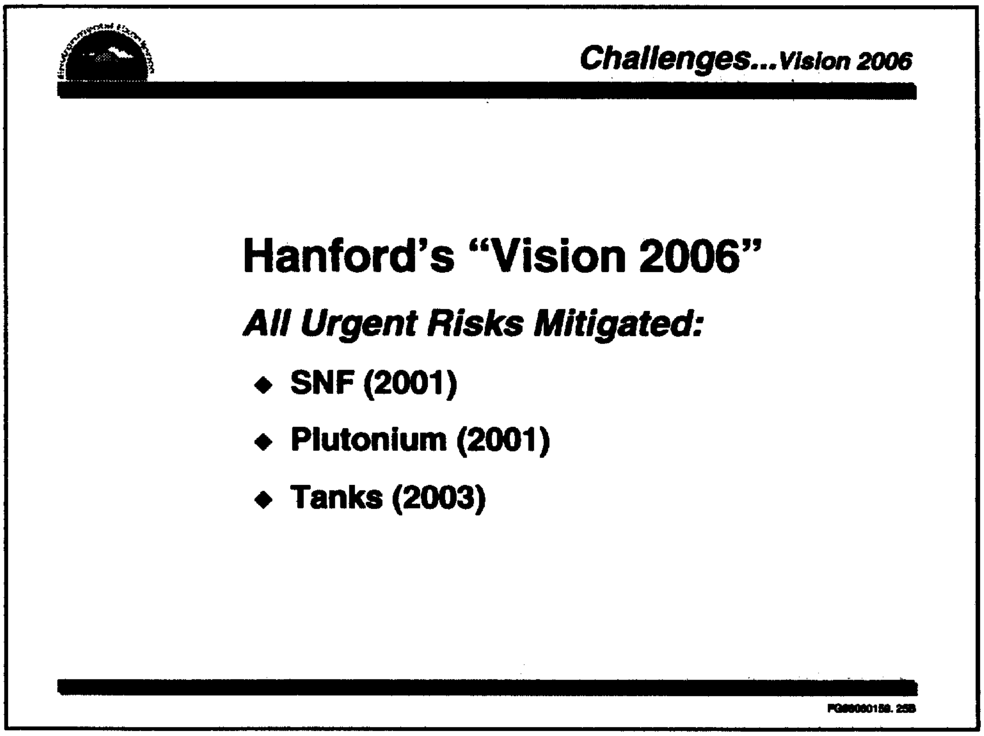
Of prime concern in meeting that challenge is the safety of the workers and the public. Cleanup operations must be conducted in a manner that eliminates or minimizes risk to our workforce and the community. Companion to that ongoing challenge is the transportation, storage, and disposition of waste, dealing with varying budgets, and meeting our obligations to regulators and stakeholders.

Challenges...

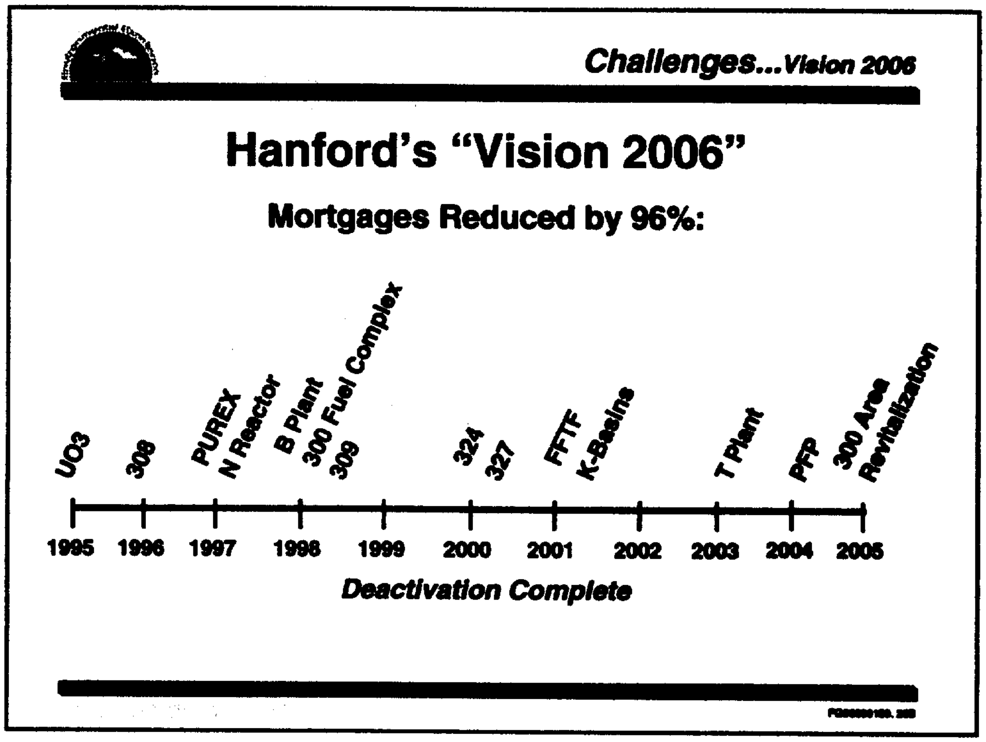
HEPA Filter - B-Plant



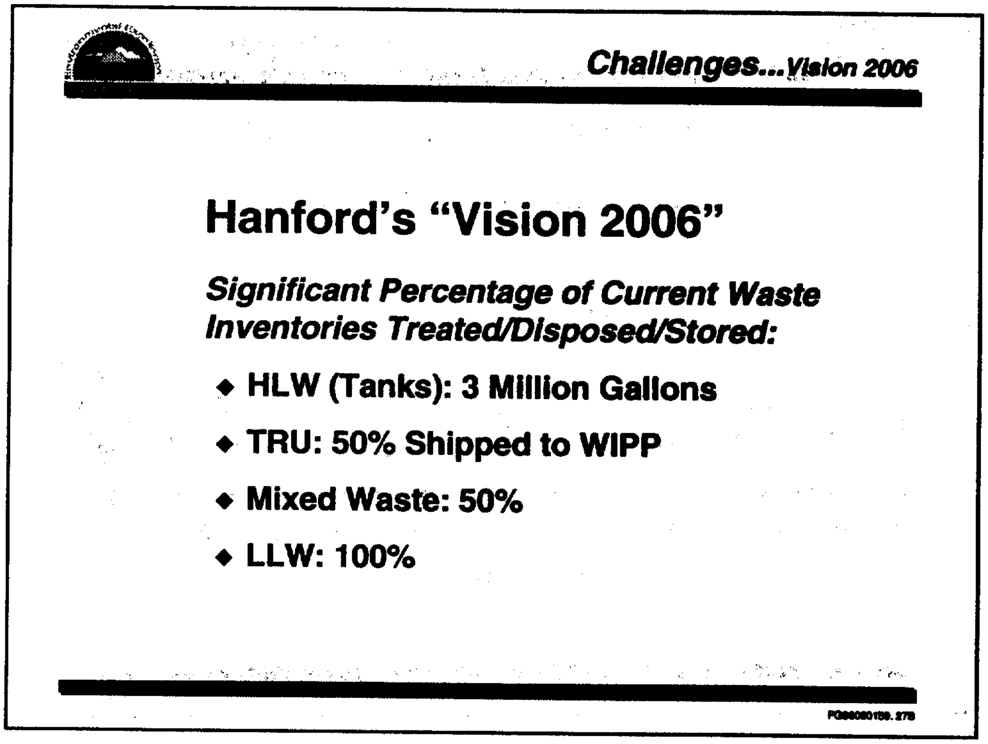
As an example of our worker safety focus, we currently are using the main HEPA Filter System to remove any radionuclides from the air in facilities. Currently, a new HEPA system is being designed with a target installation of September, 1998.



Our answer to Mr. Alm's challenge is Hanford's "Vision 2006". Within the first three years of the plan all urgent risks will be mitigated...



... our mortgages on major facilities will be reduced by 96%, and ...



... significant impact will be made on our current waste inventories.

Challenges...Vision 2006

Hanford's "Vision 2006"

Environmental Restoration:

- **7 Reactor Facilities Cocooned**
- **150+ Waste Sites Remediated**
- **Complete Remediation of all 100 Areas (Except N)**
- **Begin Characterization Work in the 200 Area**

FG96080159.28B

Our ER efforts will have placed 7 reactors in Interim Safe Storage and remediated more than 150 waste sites.

Questions

Environmental Excellence

HANFORD

and Answers

As we have seen, our past progress is notable, but our future challenge is just as noteworthy. I am very confident that our excellent contractors workforce will not only meet the challenge over the next ten years, but will exceed expectations in the process.

DISCUSSION

FIRST: Mr. Wagoner, I've heard all kinds of numbers for when this clean up is going to take place and how much it's going to cost. I recall about five years ago we had thirty years and thirty billion. And then it went up to fifty years and a hundred billion. And now I just heard ten years, but I didn't hear how many billions. But it would be, I'm sure, of interest for us to know how firm the ten year commitment is, and some idea of what the financial implications are.

WAGONER: For Hanford we have requested for the 1997 budget year just under one point four billion dollars. And for fiscal '98, including the financing of the privatized tank waste contracts, that would be a little over one point five billion. So it would run in that range between one and one point five billion per year, between now and 2006.

WEBER: I am curious to know what is the magnitude of the TRU waste, which is in suspense awaiting whether WIPP opens or not. Of that figure, are you able to estimate what proportion of the material has already been drummed?

WAGONER: I should have, but I do not have the figure off the top of my head in terms of the total volume. Most of it is going to have to be repackaged. And for that purpose we built the waste receiving and packaging facility. We are just now completing construction. I think it's essentially complete. And there we will be able to bring the waste in that's retrieved. The TRU waste of Hanford, for the most part, is buried in shallow pits that are retrievable. That will be brought into the facility, it will go through examination, characterization, depending upon what is seen through the non-destructive evaluation. Glove boxes are there to repackage the material and put it into suitable drums, meeting WIPP's acceptance criteria, whenever those get finalized. Bar-coded and then put in a position ready to load for shipment to WIPP. But I do not have the overall figure. If you are interested I can get that for you. On the TRU waste also, in all fairness, it's important to distinguish that we are talking about the so-called retrievable waste, which was placed there after 1970.

BELLAMY: The congressional mandate to complete the DOE/West Valley project would suggest to me that the vitrification of the tank waste that you have proposed, could be done at West Valley at a very significant savings to the taxpayer, if I understood your answer to Dr. First's question properly. Why isn't West Valley being used for that purpose?

WAGONER: I am not sure that the life of the melter at West Valley would be able to handle the Hanford waste. My understanding is that it will have a limited life. It's only got one tank to process, basically, at West Valley. It is the same basic design concept as DWPF, and that melter will have to be replaced periodically. Then you have the issue of transportation, what would be the suitable container for transportation to West Valley. We only need to treat in the high-level waste melter the high level fraction of the waste, so it would suggest you need a pre-treatment facility to separate the high level and low level fractions that would have to be at Hanford anyway. So it's difficult to see that you would find sufficient economy to overcome all those problems to ship it across the country. What we are doing in our approach to privatization is to ask instead for industry to show what they could provide using the technologies that have been previously developed, a lot of it outside of this country. So those are the proposals we are currently evaluating.

SESSION 6

INTERNATIONAL PANEL REPORTS ON NUCLEAR AIR AND GAS CLEANING ACTIVITIES FROM AROUND THE WORLD

Tuesday July 16, 1996
Co-Chairmen: R. Weidler
J.G. Wilhelm

Panel Members: R.R. Bellamy
J. Dyment
T. Fukasawa
R. Lee
R. Porco
J. Slawski
J.G. Wilhelm

PANEL DISCUSSION

INTRODUCTION

WEIDLER: Welcome to the International Panel session. We have a very distinguished panel today. We have Mr. Fukasawa from Hitachi Limited, Mr. Rich Porco from Ellis and Watts, Dr. Ronald Bellamy from the US Nuclear Regulatory Commission. Dr. Juergen Wilhelm, consultant from Germany, Mr. James Slawski, US Department of Energy, Mr. John Dyment, the Atomic Weapons Establishment in the UK, and Dr. Richard Lee from the US Nuclear Regulatory Commission. Each of these gentlemen has something to say, then we will open the floor to questions.

BELLAMY: I have three very brief comments that I would like to make concerning regulatory issues that could be interpreted to have an international flavor. And then Dr. Lee will follow me with some very specific international issues that the regulatory agency is involved in. The first I'd like to mention is an issue that has become of great importance to us over the last year, with our change in chairman. The present chairwoman of the Nuclear Regulatory Commission is a firm believer in verbatim compliance. Whatever the technical specifications or the regulations say, it is the way to do it, and it is the only way to do it. She is not a believer in waivers or exemptions. The present philosophy is that if there is something of such importance that it requires a waiver and exemption, then it must be something that you need to take a look at in the regulation. Maybe the regulation or the actual basis for what you're doing needs to be changed. The second issue has to do with a lot of the work that's been on-going over the past several years with respect to source terms, with respect to changes in the regulatory requirements, and the potential for, I don't want to use the term back-fit, but the potential for modifications to existing filter systems. There's been some discussion on can we remove components, can we remove some HEPA filters, can we remove some activated carbon. I'm not going to stand here and give you any of the answers to those questions, but simply to point it out to you that is an issue that will need to be addressed. And perhaps there's some lessons to be learned from some of the international experience that we will be discussing this afternoon. The third and final issue that I will very briefly mention is the topic of one of the open end papers this afternoon, and that has to do with the criteria for laboratory testing of carbon that has been in-place. The Nuclear Regulatory Commission has, contrary to what I started this brief remarks with, has approved some emergency tech spec changes and waivers over the past several months. And Mr. Lyons will be discussing that issue in great detail this afternoon. So perhaps there is some international experience that we can learn and gain from. And we can use that as we move forward in this area.

LEE: Let me tell you something on the international scene, what the agency is doing, plus the emphasis based on the office of research of the NRC. Since the NRC was formed in 1975, after we split from the AEC, the agency has maintained many bi-lateral agreements with European countries, Asian countries, and most recently the so-called former Eastern European Countries, in cooperative research. And I think there are some areas that will be of interest to the participants of this conference, in the area of aerosol treatment (*i.e.*, before you can treat it you need to know more about the sources and so forth). And I think after the TMI accident in the early 80's, the Office of Research initiated a whole series of bi-lateral agreements with European countries, and Asian countries, in cooperative research and focus on so-called severe accident research. Severe accidents are beyond design-based accidents, and we are dealing in an area where current filters are designed for design base accidents, to handle severe accidents. We know that under severe accident conditions, the aerosol loading on these filters will render them useless. Now, with the revision of the source term, we have not (because the agency is busy addressing other issues) gone back to look at the performance of filters. And I don't know, Ron, whether Region I is looking into it or not. Instead of assuming 95% of gaseous iodine (that filters have to treat), now our new source terms set iodine at 95% aerosol. So this has implications on the operating plants. And as Ron pointed out, the utilities may come in and ask for different things (related to filter performance requirement), and some of the proposals are actually in-house now. So we will be discussing with the Office of Nuclear Reactor Regulation, how to deal with these proposals. Now back to the international arena, under the severe accident agreements, we have been doing a lot of research with Japan, basically with JAERI, the Japan Atomic Energy Research Institute. It started with thermal-hydraulics cooperative research, basically looking at design base loss-of-coolant accidents; now we have extended it into severe accident research. In the severe accident research area, we also have joint agreement with NUPEC, another research organization in Japan, which we deal directly with on hydrogen issues. On hydrogen issues, we are basically dealing with failing the containment very early, very quickly, and not necessarily looking into what the hydrogen burn would do to the aerosols. In Germany, of course, we have a lot of cooperative research agreement with KfK, which now has been renamed as FZK. We also deal with GRS, *etc.* In the late 80's, we started to cooperate with France. That was the first time the agency started to cooperate with France, basically with the CEA (the French Atomic Energy Commission). And I want to point out that there is a lot of activity now going on in France the source term area (such as aerosol research in the Grenoble research center). The one major project that the agency is tracking now is the PHEBUS-FP project, located in the Cadarache Nuclear Center in the south of France. In '93, they ran the first test, using fresh fuel. In that test, initially the test results showed that 10% of the iodine coming out was gaseous iodine. That caused concern to us, because at that time a Commission paper was pending to revise the source term and we said 5% (gaseous iodine) was the maximum. The preliminary results turned out to be not true, because the initial measurement has error and it is somewhere between two and less than ten percentage gaseous iodine. The next test is going to be run some time this month, actually within a week. And that test is going to be using spent fuel from the BR3 Belgium reactor; fuel is three feet long, and there are about twenty-one rods (one control rod and twenty fuel rods). Of course, if the test doesn't run by July, it will start to conflict with the vacation schedules so it will be postponed until September. I have to tell you that Korea is launching a very ambitious program for the next ten years, spending close to a billion dollars in research to get itself in a position to compete with Japan and the US in future reactors. And the research they started ranges from thermal-hydraulics to severe accidents. So there are a lot of activities going on internationally. I think some of the results from these activities should be of interest to this conference. The agency is also faced with a very important decision, that is on the maintenance of expertise. There's a lot of dialogue now, not just within the US, but with the Europeans, concerning how we can maintain expertise. Another reason we have all these cooperative research agreements is because the budgets are decreasing, so we need to share the research knowledge. And this expertise maintenance is directly related to how we're going to fund, what type of program we will fund in different national laboratories, and what scientists we need to maintain in case there is an accident in a plant, and we need to call upon these people to address the problem. With these remarks, I would like to turn the podium back to the Chairman.

DYMENT: I'm going to try, in the space of 10 minutes to give you a very quick overview of the British Nuclear Industry, where it's come from and where it's going, as a background to the air cleaning problems. In trying to do this I feel a bit like the man on the radio who does a Shakespeare play in 30 seconds.

WORLD SCENE:

This micro-history slide of UK and world nuclear power (from the Nuclear Engineering Handbook, 1995) shows the numbers of reactor units commissioned in first power in various countries during the four decades starting 1956/65. As you see the UK was virtually the sole player in the first decade with around 20 units. In the second decade the rest of the world commissioned over 100 while the UK dropped back to 6. In step with the rest of the world, the UK increased again (second generation reactors) in the 76/85 decade to 10 or so units and dropped back again in the last 10 years.

UK SCENE:

The current UK situation is that 10% of inland energy consumed comes from nuclear power, and 25% of electrical energy generated is nuclear. The generating plant consists of 8 Magnox stations (uranium metal fuel clad in alloy), 7 AGR stations (e/uranium oxide fuel clad in stainless steel), both types with carbon dioxide coolant. Finally, we have 1 PWR station. Reprocessing of these various fuels takes place largely at the Sellafield sites of British Nuclear Fuels. Some reprocessing also takes place at the Dounreay site of AEA. A "drystore" option for the long-term storage of spent fuel has been considered as an alternative to reprocessing.

DECOMMISSIONING:

Various strategies for decommissioning obsolete generating stations are under discussion; the issues centre largely on the (duration of the) delay before dismantling and the safe encapsulation of the installation meanwhile. Decommissioning of redundant nuclear facilities other than power reactors is well advanced within several organizations, *e.g.* decommissioning of the Capenhurst diffusion enrichment plant is complete and the bulk of the metals has been recycled.

WASTE:
Low level nuclear waste is currently disposed of at the Drigg repository, operated by BNFL. Intermediate level waste is currently stored at the sites where it is generated, pending construction of a deep disposal facility by NIREX, the Nuclear Industry Radioactive Waste Executive. The commissioning date for this facility is still some 15 years away. High level waste is currently stored on the site of origin pending vitrification which is in progress.

PROGRESS TOWARDS DISPOSAL:
NIREX is investigating the hydro geological characteristics of a proposed disposal site near Sellafield by means of a "Rock Characterization Facility" (RCF) which is currently being designed. Authority to proceed with construction has not yet been obtained.

NUCLEAR AIR CLEANING:
Many or most UK nuclear air cleaning installations employ HEPA filters. The majority of these use the square deep-pleat format mounted in bag-change housings. There are some plenum chamber mounted installations but they are perceived to present greater problems at changeout and *in situ* testing. Circular (cylindrical) format HEPA filters are now being used to a large extent in new plants. They have 950litre/sec airflow capacity (>2000CFM) and will fit into a standard waste drum. They are also acknowledged to be much more compatible with remote changeout requirements than square format units. In-place or *in situ* testing of HEPA filters is routine at all nuclear sites.

UK NUCLEAR POLICY:
The UK government has published two documents on nuclear policy in the last year, one relating to nuclear power, the other to nuclear waste. The former, the Nuclear Review, had 3 key conclusions:

Firstly, that nuclear power will continue to play a key role in meeting UK energy needs. Secondly, that public sector intervention in the electricity market is unwarranted. Thirdly, that as many UK Nuclear Stations as practical should be moved to the private sector.

Accordingly, the more modern AGR and PWR stations have now joined the fossil fuel generators in the private sector as "British Energy", with only the older Magnox stations remaining in the public sector as "Magnox Electric".

The key findings of the second policy statement, the Waste Management Review, were as follows:

1. Deep disposal of ILW continues to be Government policy; Nirex should implement plans for the repository without delay.
2. Deep disposal of vitrified HLW is a favored option.
3. A range of potentially acceptable decommissioning strategies is recognised, including "Safestore" concepts.
4. In general, radioactive wastes should not be imported/exported to/from the UK.
5. Waste substitution is an acceptable option provided there is environmental neutrality for the UK.

WEIDLER: Our next speaker Richard Porco from Ellis & Watts, Richard is going to talk about developments in China and Korea.

PORCO: One of the questions that I am asked very often is why do we, on the ASME code committees, work so diligently to develop standards, when in the US we're not working on any new nuclear power plants. We put a lot of effort into our work, and other than the DOE, commercial power plants are mainly working on retrofits or upgrades. The amount of work that goes into the codes and standards seems phenomenal to support that effort. Why we work on the codes that diligently and what we're supporting is a very vibrant commercial nuclear power industry in the Orient. I think most of you are aware of Korea's aggressive nuclear program. The key to Korea, China, and other emerging countries is to develop an infrastructure to support the rapid growth necessary. Parts of that infrastructure would be would be communications, another is the road systems. The main part is energy. This is a slide of Korea's operating plants. They currently have eleven operating plants that generate more than 9,100 megawatts. The first unit Kori Unit was brought online for commercial operation in 1978, and over the period of the next sixteen years, KEPCO brought on ten more reactors with the last one, YGN Unit 4, coming online this year. KEPCO also plans on bringing another nine reactors online within the next seven years. At least 6 more are planned, including a reactor for North Korea. This pace seems phenomenal compared to the pace the U.S. built reactors in the 70's and 80's. Korea is actually supporting this effort, and it has helped their economy grow quite rapidly. Other countries that are looking at this rapid growth and trying to imitate Korea are Turkey, Thailand, India, and Pakistan. Japan has always had an aggressive nuclear program, and I think Dr. Fukasawa will also talk about Japan.

I'm going to discuss nuclear energy in the People's Republic of China. Since the 1970's China started to talk to the world about its civilian nuclear power applications. So far, China has three reactors. The 300MWe indigenous pressure water reactor at Quinshan and the two 950MWe French PWRs at Guangdong near Daya Bay supply less than 1% of China's electricity. The successful entry of the three reactors into commercial service in 1994 has stimulated a sense of confidence in nuclear power within China. China's gross national product has increased more than 400% since 1980. Shortages of electricity estimated to average around 20% are blamed on China's new industrial enterprises operating below their potential capacity. To achieve GNP annual growth at the projected rate of 7-10% per year for the rest of the 1990's and the first decade of the twenty-first century, the increase in the electrical production will be required. Right now there are four additional plants under construction in China. Quinshan Units 2 and 3 are under construction and construction of two more plants at Quangdong, LINGAO Units 1 and 2, has begun. In addition, reactors are planned for Quinshan Units 4 and 5, these are Canadian CANDU 6 reactors. And two more at Wufangding, and these are PWR's. They are Russian UVER-type under an agreement with the St. Petersburg Atomic Energy Development Company. Korea has also entered into agreements with the China National Nuclear Corporation, and they are working on what they consider the Korean standardized nuclear power plant, which is similar to Bechtel's Standard Nuclear Unit Power Plant (SNUPPS) and other standardized nuclear power plants we had in the 80's. The Korean standardized plant is based on UGN 3 and 4 and ULCHIN 3 and 4 plants. Proposed sites are Shangdong and Fujian Provinces. Each site is different enough to affect the design of most of the equipment. The same thing will be true when they are adapted for the China market. In addition, there are seven additional sites under consideration. The whole area along the coast of China is looking to support and finance a nuclear reactor in their Province. There is a possibility for thirty to forty reactors. The problem here is obviously financing. Even if China achieves 50% of its projections, it would still be a major accomplishment. The purpose of showing you all this is that there is a commercial nuclear market out there. And there is also a major need for our codes, standards, developments and equipment.

WEIDLER: Thank you Mr. Porco. Our next speaker will be Dr. Wilhelm.

Provisions for Containment Venting in Germany.

J.G. Wilhelm, Consultant

Abstract.

In this short paper an overlook is given of the systems developed in Germany for filtered containment venting and their implementation in nuclear power plants. More information on the development can be found in the Poceedings of the DOE/NRC Aircleaning Conferences (1, 2, 3)

In Germany, 28.8 % of the electric energy is produced by 19 nuclear power reactors. No new power reactor is expected to be built at least within the next ten years, but France and Germany cooperate in the development of a future European Power Reactor (ERP). This reactor type will be fitted with a core catcher and passive cooling in order to avoid serious consequences of a hypothetical core meltdown accident so that provisions for containment venting are not required.

In May 1990, the German Reactor Safety Commission specified the requirements on removal systems for filtered contaiment venting. Some data for LWRs are given in Tab. 1.

Reactor Type	PWR	BWR
Total mass of particles to be removed (kg) (including a safety factor of 50 %)	60	30
Decay heat (kW) Aerosols Gaseous iodine	 2 5	 180 7
Content of steam in off-gas (%)	< 100	<100
Droplet aerosol by condensation (g/m^3) *	< 5	< 5
Beginning of venting after core meltdown	2 -3 d	> 4 h
End of containment venting	7 d	7d
Removal efficiency (%) Aerosols Iodine, elemental Iodine, organic	 ≥ 99,9 ≥ 90,0 0,0	 ≥ 99,9 ≥ 90,0 0,0

* in tubes, fittings and containment

Tab. 1 Requirements and conditions for filtered containment venting in Germany

Backfitting measures allowing filtered containment venting have already been taken in the exsisting German power reactors. For the removal of droplets, mist and particles in the µm and submicrometer ranges, filter units were developed on the basis of packs of metal fiber fleeces with decreasing fiber diameters. These filter units were designed on the basis of experience first gained in droplet and mist removal with a metal fiber droplet separator of extremely high efficiency, to be installed upstream of HEPA filters of conventional design. When the factory producing the fiber fleeces from a special stainless steel was able to reduce the fiber diameter down to 2 µm, the target of the original development was extended to build a droplet-, mist- and particle filter unit, completely made from stainless steel. The tests with aerosols of droplets, mist and particles showed that removal efficiencies > 99,99 % could be reached by the proper selection of the fiber diameters and the depth and arrangement of the different fleeces. Also it could be demonstrated that, even under extreme droplet and mist loading of the atmosphere to be filtered, no water reached the final section of the filter unit provided to remove dry aerosol particles with diameters in the submicron range.The design of the combined metal filter units allows to transfer the mechanical strength from the fiber media to perforated sheet metal or heavy wire mesh. Organic material is not used. In this way, the problems connected to the decreasing tensile strength of the HEPA filter media due to pleating and effects of wetting and heating, primarily challenging the organic binder of the media, could be avoided.

Filter units of the metal fiber type described were built to clean up the containment venting off-gas both by dry and wet filter methods. The "dry filter method" has been developed in two versions, named the Krantz/RWE system and the Krantz/KfK system. The Krantz/RWE system is shown in Fig. 1. The filter unit for aerosols is installed inside the containment and upstream of the pressur relief trottling valve for the off-gas. The dimensions of a typical module are given in Fig. 2 which includes also data on the required and proved performance. The loading capacity for particle aerosols is tested with a plama torch generated tin dioxide of 0.5 µm MMD. Uranine is used for the final test of the removal efficiency of each unit fabricatet. The decontamination factors are normally above 10,000. The expected diameters of particles, airborne in a PWR containment atmosphere at the start of filtered venting, are much larger when calculated with the NAUA-Code. In terms of the removal efficiency and pressure drop of the filter unit, the test aerosols are much harder to trap.

In Fig. 3 the dimensions and data are given for an iodine sorption filter module. The iodine sorbens is a zeolite, used in form of ball shaped granules with diameters between 1 and 3.5 mm. To prevent potential catalytic reactions between hydrogen and oxygen on the surface of the sorbens , an binary doped zeolite named Baylith ID 625 is used. The iodine is trapped mainly in the form of silver iodide. The iodine filter module is situated in the auxilary building behind the pressure relief throttling valve. The isenthopic expansion of the vented hot gas-steam mixture on the pressure relief valve down to nearly atmospheric pressure will result in a dry off-gas, containing overheated steam. During the first operational period of the originally cool iodine filter, condensation is avoided by the heat of adsorption of steam on the dry zeolite sorbens.Three German PWRs are fitted with the filter systems shown in Fig. 1.

In Fig. 4 the Krantz/KfK dry filter system for the filtered containment venting is represented. In this version of the dry filter method, the droplet separator and aerosol filter modules are combined with the iodine filter modules and the whole filter unit is arranged in the auxiliary building downstream of the pressure relief valve. The dimensions and the required and proved data of a filter unit, built for a volumetric flow rate of 18,000 m_n^3/h, are given in Fig. 5. Again, three German PWRs are equipped with this dry filter system. The avantages of both dry filter systems are mainly a result of the exclusive use of passive components. Emergency power and the supply of cooling water and chemical additives are not needed and an extremely high stability at different temperatures and radiation levels can be achieved

Also a "wet filter method" to clean the vented off-gas during a core meltdown accident was developed in Germany. This removal system includes a Venturi scrubber and a metal fiber droplet-, mist- and particle filter unit, in principle the same as mentioned before. The Venturi nozzels, scrubbing solution and the filter unit are inside of a pressure vessel. Because the scrubber is arranged upstream of the pressure relief valve (Fig. 6), it is working at a pressure near the containment pressure. During venting, the scrubber is operating in a sliding pressure mode. A large exchange area of the scrubbing solution, sucked into the throats of the Venturi nozzels, is generatet by a very high difference of the velocity between the vented gas-steam mixture and the fine droplets of the entrained scrubbing solution. Another scrubber version can be operated close to atmospheric pressure and was developed for containments with a low design pressure. To remove iodine, the scrubbing solution contains sodium hydroxide and sodium thiosulfate. To reach a high removal efficiency for organic iodine, a dry iodine filter can be integrated in the final assembly. Removal efficiencies for aerosols of > 99.95 % and > 99 % for elemental iodine have been published (3). Thirteen nuclear power reactors in Germany are already equipped with the scrubber-filter system.

The Multiway Sorption Filter is a shaft type filter housing built to pass the exhaust air stream to be cleaned two times through the same sorption material, saving up to around 50 % of the material needed to operate with a high decontamination factor during a long time of operation. It was originally developed for radioiodine removal. The activated carbon, contained in the lower part of the filter housing and previously used as long as possible for iodine removal in the upper part of the housing, is still good enough for pre-adsorption of air pollutants. The construction of this counter current filter guarantees an exact bed depth and stay time. It is now widely used in German power reaktor stations and, as a fall out of a nuclear development, in the conventional industry. In a radioactive waste burning plant, the MWS filter is used in the off gas system to reduce the dioxine to less than 0.5 nanogram per cubicmeter. No change of the charcoal layer was necessary during an operation period of more then three years.

References:

(1) H.-G.Dillmann, J.G. Wilhelm, "Investigations into the design of a filter system for PWR containment venting", CONF-900813, Vol. 2, p. 898 (1990).

(2) H.-G. Dillmann, H. Pasler, J.G. Wilhelm, "Off-gas cleaning devieces for containment venting", CONF-880820, Vol. 2, p. 709 (1988).

(3) B. Eckardt," Containment venting sliding pressure venting process for PWR and BWR plants - process design and test results", CONF-900813, Vol. 2, p. 876 (1990)

Filtered Containment Venting

The Dry Filter Method

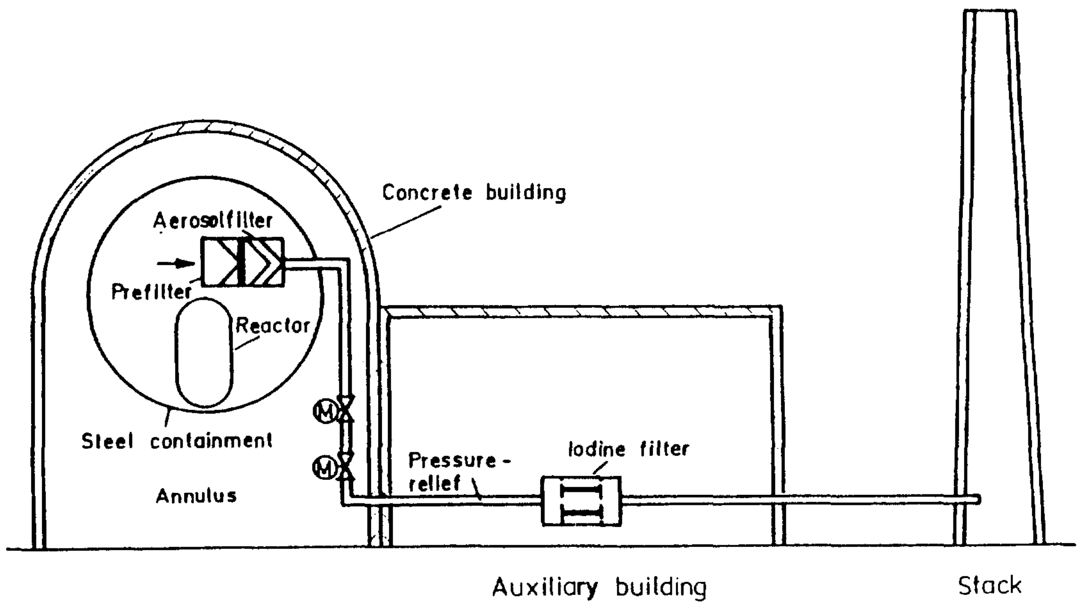
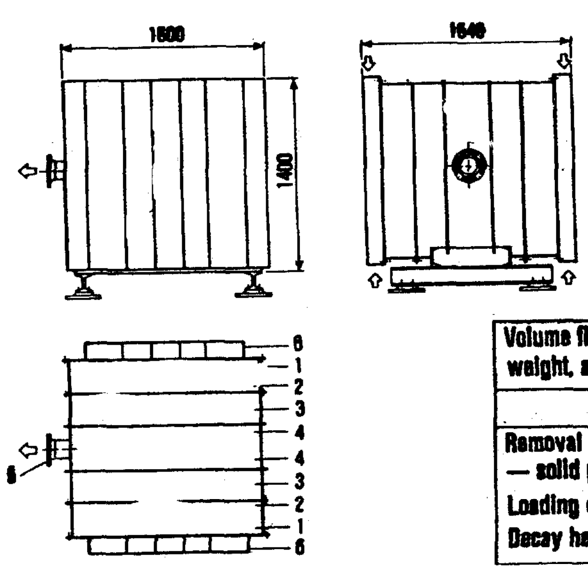


Fig. 1 The Krantz/RWE System

Metal fiber filter module



Legend

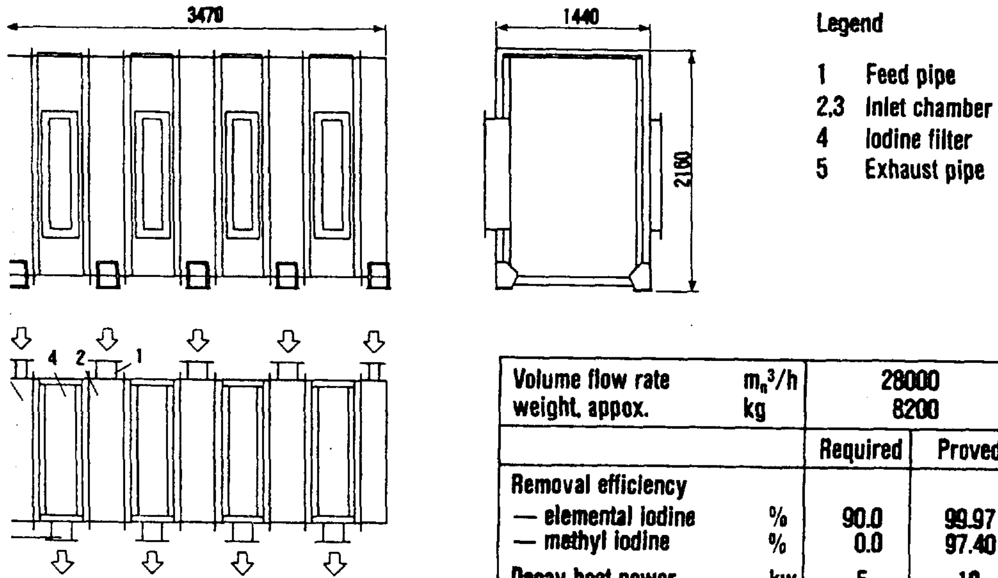
1 Droplet separator
2,3 Prefilter
4 Finefilter
5 Exhaust pipe
6 Inlet

Volume flow rate	m_n^3/h	9333	
weight, appox.	kg	2000	
		Required	Proved
Removal efficiency — solid particle	%	99.9	99.99
Loading capacity, SnO_2	kg	60	80
Decay heat power	kw	2	20

Fig. 2

Filtered Contaiment Venting

The Dry Filter Method



Volume flow rate	m_n^3/h	28000	
weight, appox.	kg	8200	
		Required	Proved
Removal efficiency			
— elemental iodine	%	90.0	99.97
— methyl iodine	%	0.0	97.40
Decay heat power	kw	5	10

Fig. 3 **Iodine sorption filter module**

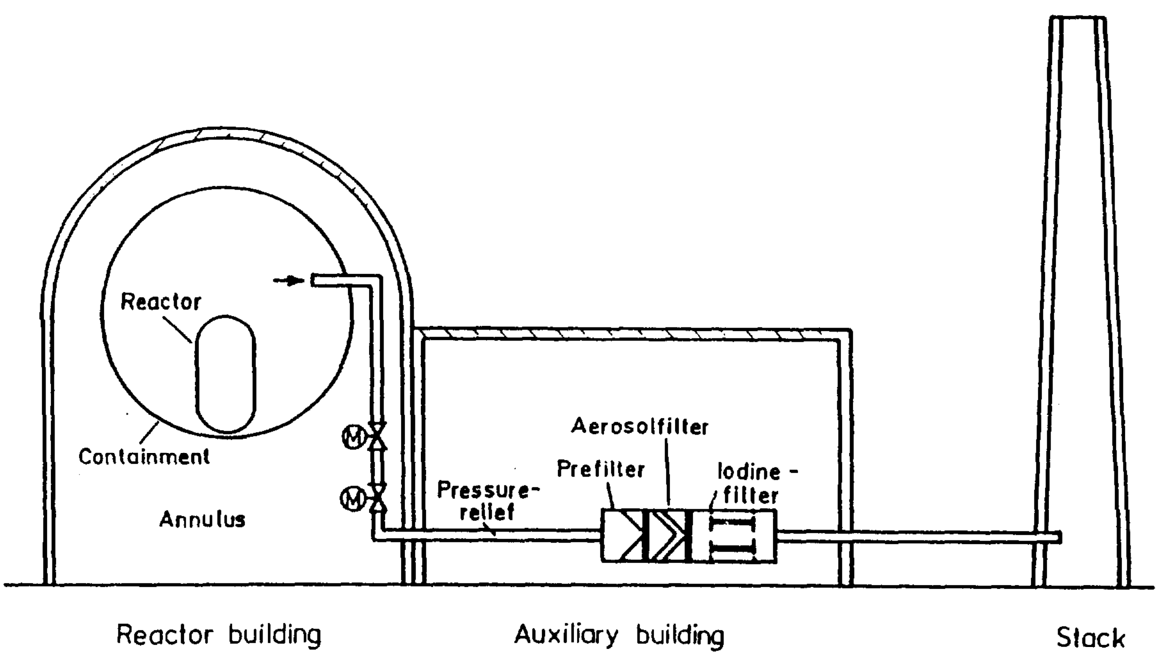
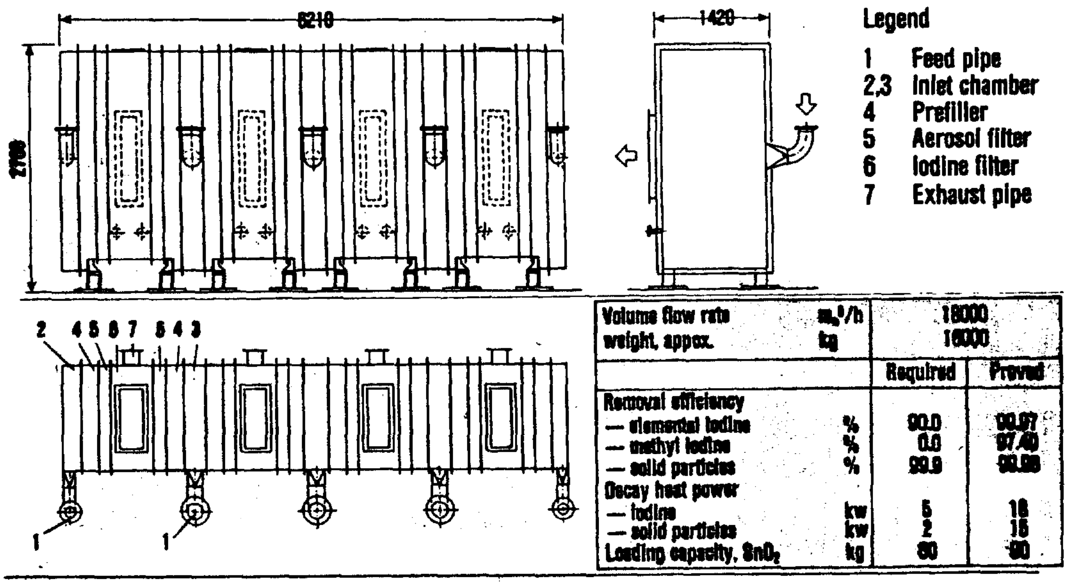


Fig. 4 The Krantz/KfK System

Filtered Contaiment Venting

The Dry Filter Method

Combined metal fiber and zeolite iodine filter module



Volume flow rate	m_n^3/h	18000	
weight, appox.	kg	16000	
		Required	Proved
Removal efficiency			
— elemental iodine	%	90.0	99.97
— methyl iodine	%	0.0	97.40
— solid particles	%	99.9	99.98
Decay heat power			
— iodine	kw	5	18
— solid particles	kw	2	15
Loading capacity, SnO_2	kg	60	90

Fig. 5

The Wet Sliding Pressure Venting Process

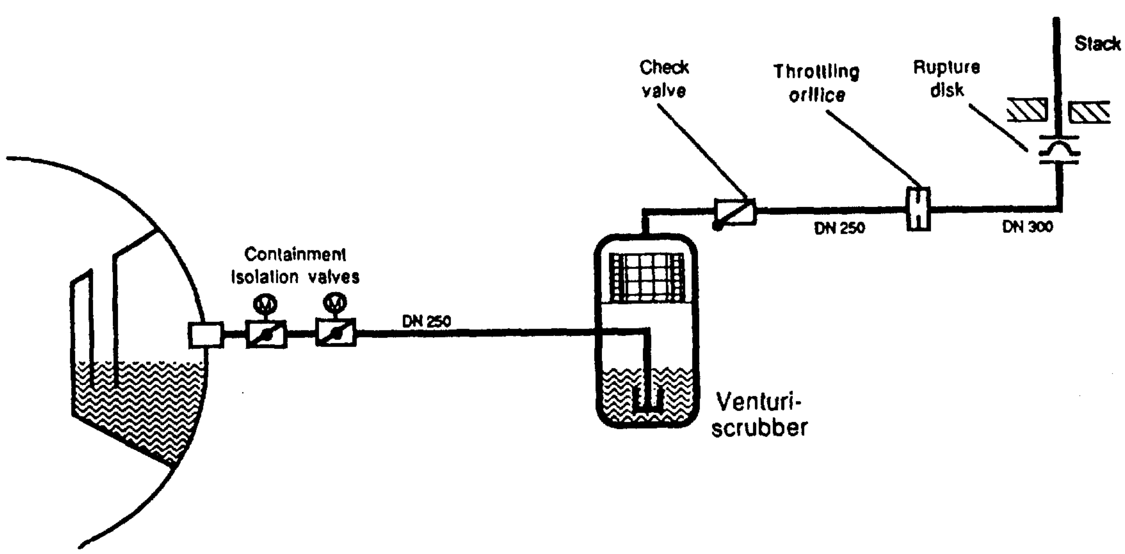


Fig. 6 Flow Diagram of One Version by Siemens

FUKASAWA: The title of my talk is the present status of the Japanese nuclear industry. This includes off-gas treatment activities, but is mainly about nuclear power generation on these items written here. This figure shows you the capacity and operation data for nuclear power units in the world, on which I would like to show you Japan's nuclear position in the world. For plant capacity, Japan is in the third position in the world. These data I explain here are nuclear electricity share and average capacity factor. For both data, Japan is in the thirteenth position in the world. For plant capacity factor, Japan exhibited 80.2% in fiscal year 1995, excluding 18.3% periodical inspection stop. So 1.5%, or 0.3 events per unit per year, is unplanned outage frequency, which I think the smallest value in the world. This figure shows nuclear power plants in Japan. Fifty operation units include 26 BWR's in green color, twenty-two PWR's in blue color, and one gas cooled reactor in Tokai-one unit, and one prototype ATR, Fugen here. Among 4 nuclear units under construction there is one prototype FBR, Monju here, and 2 advanced BWR's here, Kashiwazaki-Kariwa-6 and 7 units. Two units are on order, and an additional fourteen units are being considered now. Fuel cycle facilities are operated or under construction at the very northern part of Japan's main island Honshu. The facilities are centrifugal uranium enrichment, Purex reprocessing, low-level waste shallow disposal, and high level vitrified waste storage. I will show you briefly the status of the Fugen, Monju, advanced BWR's, GCR, and fuel cycle facilities. This is the Japanese prototype advanced thermal reactor Fugen of PNC, which has U or MOX fuel, a heavy water moderator and the light water coolant. I think ATR is useful for Pu consumption before FBR, but no further ATR development was decided last August. Hitachi was one of the main contractors of ATR, so I was so sad to hear this news. This is the Japanese prototype fast breeder reactor Monju. Because of the lack of energy resources, Japan is proceeding FBR project. Monju achieved initial criticality in April 1995. But six months later a leak of non-radioactive sodium occurred. The leak portion was just part of the secondary loop. The leak portion is here, and the missing part was found at the bottom of the super heater. The sodium leak occurred exactly on December 8, 1995. I cited these figures from Nuclear News. The leak position was about one meter from the concrete wall of the containment vessel room. The leaked sodium amount was seven hundred kilograms, and four hundred fifty kilograms have been recovered by now, two hundred kilograms were dispersed to the environment, and twenty kilograms are still in the ducts. Sodium flow vibration and repeated thermal stress broke the thermocouple tube and caused the sodium leakage. This missing part was found in this distributor at the bottom of the super heater. Now the public concern is focused on this subject. I hope Japan can continue the FBR development program. The is the world's first advanced BWR's Kashiwazaki-Kariwa-6 and 7 units. The schedule is shown here. This month, the first one will become full power and this winter commercial operation. The characteristics of ABR are the internal pump, the fine motion control rod drive, and the reinforced concrete primary containment vessel. This is the joint venture of General Electric, Toshiba and Hitachi companies. The decommissioning program for nuclear reactors is also proceeding in Japan. For Japan power demonstration reactor of JAERI, the decommissioning was finished this March after testing such a device for remote removal of in core components. For the first commercial reactor, Tokai-1 of JAPCO, Japan Atomic Power Company, the decommissioning was decided last month. Among a hundred and sixty thousand tons of generated waste, they think eighty-five percent can be treated as non-radioactive. This figure shows the progress in fuel cycle facilities. The uranium enrichment plant started operation in 1992. Final capacity will be fifteen hundred tons SWU per year. The low level waste disposal center started operation in 1992. Final capacity will be three million drums disposal. One drum is two hundred liters or fifty-five gallons. The high level waste management center started operation in 1995. Final capacity will be three thousand canisters storage. The reprocessing plant will start operation in 2003. Final capacity will be three thousand tons heavy metal for spent fuel pool and eight hundred tons of heavy metal per year for the reprocessing. I show you two R&D activities in the field of nuclear fuel cycle. The partitioning and transmutation program aims at reducing toxicity of high level waste by recovering long-lived nuclides and converting them into short-lived nuclides. We call this the Omega Project which has been done for about ten years now. PNC presented the actinides recycle program two years ago. The concept of actinides recycle is described here which aims at the effective use of minor actinides such as neptunium, americium, and curium in the future FBR cycle. Finally, I will explain the systems and recent activities for off-gas treatment in Japan. For nuclear power plants, the United States is our teacher. We are also looking for the leak test method without using Freon for standby gas treatment system. Source term evaluation is also being done with non-volatile cesium iodide. For reprocessing plants, the Rokkasho processing plant will adopt German silver adsorbent of iodine removal. In this case, Germany is our teacher. For the recycle equipment test facility for FBR fuel reprocessing of PNC, they will also adopt silver adsorbent. Tokai reprocessing plant now in operation removes iodine by the alkaline scrubbing method, and is now considering the iodine removal from the solution by silver precipitate. Crypton evolved removal is also being considered by PNC. For enrichment and fabrication plants, uranium recovery from HEPA is considered by vibration and acid leach methods.

<u>WEIDLER:</u> Thank you Mr. Fukasawa. Our next speaker is James Slawski from US Department of Energy and then we will open the floor to questions.

<u>SLAWSKI:</u> I think I need to say that anything I say at this meeting is my thoughts and I do not speak officially for the Department of Energy. That should cover what Ron said earlier this week in so many words. I have been focusing my work in this area on standards, picking up some old DOE standards and revising them and now working with ASME, the CONAGT Committee on working on their standards, specifically the one on HEPA filters. We are proceeding at this time with the resolution of the DOE draft standard for specifications. We have redlined strike out or revision one of the draft that we put out last year. After our meeting earlier this week we will be doing revision two of that. From that time we will be going through on a line by line comparison between that and the FC Section of AG-1. I am quite aware that there is a Federal Law that where it is practicable we adopt a non-government standard and I am working to head in that direction for the department. At this time, I'm aware that the Department of Energy does not have a driver, it does not have a mandatory requirement on filters. We seem to be operating on inertia based on work that people like Humphrey Gilbert started years ago. We are talking about having a shell statement which could be a DOE order, a policy statement. We could get something added in to 10CFR830, the Quality Assurance Rule. Other considerations are 10CFR834, Radiological Protection for the Public, and 10CFR835, Radiological Protection for Occupational Safety and Health. These are just things that we are considering at this point. We are aware also that we need a technical basis for maximum life of filters and we are concerned about those factors that I hear from people in this meeting. Our interest, we have radiological as well as non-radiological concerns in this area. On the radiological side, the overwhelming driver, my understanding is, the binder on the media as it's exposed to radiation. We also have other organic compounds, the plywood and the box itself, the glues that hold the plys together, the glues that hold the filter pack to the case and then the seal to the edge of the case, the gasket. We are looking for a technical basis to evaluate those for the life expectancy or maximum life that we might derive. Rocky Flats has been funded to do some studies on aging and we are very interested to see the outcomes of that. We are finally we are working on getting out the draft for the air cleaning handbook, and our target is to get that out for review by the end of this calendar year. And Werner Bergman is getting optimistic that will happen. Those are my comments at this point.

DISCUSSION

WEIDLER: Thank you very much. Now I open the floor to questions.

FIRST: I do not want to sound repetitive, I asked this same question this morning, but what is the panel's view of the of prospects for international standards with regard to nuclear air and gas cleaning, particularly, and other aspects of nuclear constructions in general?

PORCO: I can only speak from certain countries but Korea has adopted the ASME codes and ASME AG-1 in a requirement in their equipment specifications. China has adopted them on certain projects, very cautiously. In other words they will invoke codes and standards and then depending on how much money they really cost they may reduce the qualification requirements. Taiwan has adopted the ASME requirements. The proposed plants in Thailand and Turkey have either ASME requirements or Canadian standards which are, in my opinion, based on the ASME standards. Some of the other panel members may want to comment.

WILHELM: Well in Europe, we have the Eurotome and Eurotome is in charge of all the regulations that should be the same. It is not at the moment with respect to filter testing also, but it continues to unify Europe with respect to health physics with respect to radioactive material or not. I see a good future for a generation over Europe because as I told before France and Germany together developed a pressurized reactor. And if you start this way you will also unify your air cleaning systems, and what you ask for the air cleaning system. At the moment it is not the case. At the moment Germany has its own regulation, France has its own regulation, too.

DYMENT: Looking at what has happened in the past on standards in filter testing, one can look for example at the ASHRAE standard which started out as 52-68. Over the years it has gradually become adopted very widely, and two or three years ago it was accepted as a European standard. So it seems that if a standard works and continues to be accepted, it will become more widely used. Eventually it may become *de facto* an international standard. I think that for nuclear structures and testing procedures, it could be that the regulatory frameworks in different parts of the world would require differing standards to be applied. I think therefore that it would be difficult for standard documents from one country to be applicable in another without modification or adaptation. Looking at what we were discussing this morning on *in situ* testing standards, in the UK our *in situ* procedures are not national standards. Various organizations and sites have developed their own procedures for these tasks; they may ultimately come together as a national standard or more likely as a European standard. Whether it would grow from there to be an ISO standard remains to be seen, but it is going to be a long term process and we can just wait and see.

FUKASAWA: As I said to you, Japan deferred US standard for orchestratement in nuclear facilities. But in general I think Japan's rule is more severe because, for example, Japan has many earthquakes, small , large and so on.

WEIDLER: As you can see, Dr. First, that is a difficult question to answer. Not impossible, but it will take a lot of work in the years ahead.

RICKETTS: I wonder if I might change the topic of conversation a little bit. I'd like to address several questions to representatives of the NRC, either Dr. Bellamy or Dr. Lee, or whomever else might be able to answer. I'm asking in the context of using regulatory guidelines to drive changes in component performance standards that would be documented in the form of codes and standards, in particular, HEPA filters. And I'm wondering what timetable the NRC has for updating, revising and releasing their regulatory guidelines. I'm thinking in terms of Regulatory Guides 1.52, 1.14, and maybe 1.76.

BELLAMY: To be very honest with you, I had hoped beyond my wildest dreams that question would not come up at this conference. I have no clue as to when, or even if, the agency will be revising Reg. Guide 1.52. I would hazard to say that it's not even on the active working list as far as I'm aware of. So I think the direct answer to your question is we're not working on it and not in the near future. That was the second part of your comment. My personal opinion on the first part of your comment would be that I wouldn't look to the regulatory agencies to drive what the criteria should be for the components. I would turn that around and I would say that the ASME committee, other industry groups, such as NHUG, should be coming up with those criteria, and then coming to us and saying here is the industry consensus, here is what we think is appropriate. Since we are working actively on those committees and on those groups we should then say yeah, verily, and endorse it. I would turn the first part around that way and throw the onus back on the industry as a whole. I am speaking for four people, anybody disagree or have any....unless Dr. Lee knows something else about revising Reg. Guide 1.52, I don't believe that's on our agenda.

WEIDLER: I would just have one comment, Dr. Bellamy. I would love to see the NRC review and adopt AG-1. Is there any plan in that future?

BELLAMY: Not that I am aware of. My understanding of the situation is that we would take a look at specific sections of that and if the need arose we would endorse them in individual regulatory guides. But again, we're discussing an area that does not have a very high priority right now with the agency. Jim Lyons, please...bail me out.

LYONS: With respect to AG-1, in the improved standard Tech. Specs., it is one of the options that you can use to reference it, instead of other standards. So, in a sense, the staff, by issuing the improved standard Tech. Specs. says this is an option, it's something that we would accept.

RICKETTS: I wonder if I could follow up a little bit. Doesn't the NRC essentially in the end carry the ultimate responsibility for the public health and safety with regard to nuclear facilities? In that respect, don't they really need to take the lead on something like this in their guidelines?

BELLAMY: Obviously the answer to your first question is yes, our charter is to protect public health and safety. But I think before I would be comfortable in recommending to our management that we take that step of generating any new criteria or revised criteria, I think we first have to make the case that what we now have out there is not adequate to protect public health and safety. And I know that I would not be able to justify such a statement at this present time. When the Atomic Energy Commission was split back in 1975, the purpose of that split was very clearly to separate the promotion arm of the nuclear industry from the regulatory arm of the nuclear industry. And I personally would have a difficult time somewhat justifying why the generation of new components, so to speak, would not be more in the lines of promotion of nuclear power. And therefore I would probably try to turn your question around to let the Department of Energy address it.

RICKETTS: While we have you up there, I wonder if you could address one last question. Could you clarify the relationship between NRC and DOE regarding whether DOE is subject to NRC guidelines as far as facility operation goes?

BELLAMY: Jim, I think you are probably better to address that than I am. I could answer it but, please, try first.

SLAWSKI: I am not sure I know the answer to that because it is really far outside my turf.

BELLAMY: Then I guess my answer to that would be, I am not aware that the Department of Energy takes the NRC criteria, regulations, regulatory guides, standard view plans, whatever, and implements them on a one-to-one basis. My experience has been that they take the criteria and they use whatever they think is appropriate. When it fits it fits, and when it doesn't, it doesn't.

HAYES: I am aware that at the present time I believe we have two resident inspectors, one at the Portsmouth facility and one at the Paducah facility. I don't know exactly how that originated but it's my understanding that we do have some people there. It is similar to having resident inspectors at power plants. And I also know that there has been under discussion in the Congress the question of having the NRC oversee certain activities at DOE facilities, but that is still in the formative stages at this point.

BELLAMY: Jack is correct, there are four residents at the two GDP facilities. When these resident inspectors come up with findings or violations, there is a major discussion going on now as to exactly what they would be called and how the Department of Energy addresses them.

ANON: Did you say Portsmouth and Paducah? Aren't those United States Enrichment Corporation facilities?

BELLAMY: That is correct.

KOVACH: I always like to come to these meetings and try to explain to DOE and NRC what they are really doing. We do not have enough time to explain to them what is it that they should be doing, because that takes a long time and they will not listen. Again, US Enrichment Corporation is in the process of privatization. The DOE philosophy and the DOE interagency agreement is that privatized facilities will be phased over to NRC for regulation. I think I mentioned it in my ramblings the first day that the tank waste remediation system privatization initiative, that John Wagoner talked about also, is, except for the early demonstration phase 1A, proposed to be under NRC regulation and not DOE regulation. In the meantime DOE will be in charge of only radiological safety regulation. All other regulations will be turned over in the privatized sites to OSHA, Ecology, or Department of Health, as an example, in Washington, just like any other private organization. So that is the reason why you start seeing NRC residents at some of the facilities. There is an interagency group composed of NRC Headquarters, DOE headquarters, and some of the DOE site operations offices, trying to streamline the phase-in of the new NRC regulations. That is also the reason for some of the discrepancies as to who is doing what. As far as revisions of regulatory guides or making changes in the regulatory guides, I think it was pointed out several times in the past, that there are mistakes in them. Basically, they are unenforceable as they are, and really, if the Chairman of the Nuclear Regulatory Commission is interested in a verbatim enforcement of everybody who claimed Regulatory Guide 1.52 compliance she would probably have to shut down half of the operating nuclear power plants immediately. So we still have discretionary enforcement of some of the regulations. I am greatly troubled, though, when both in public meetings and in an open forum, like the conference here, or in not closed meetings, but open to the public in discussions with NRC personnel, you hear statements, "well, yes this is technically indefensible but this is what we are doing." I think once we get to this point the technical basis of this whole industry is going down hill real fast. This is an area where I feel we definitely have to change. As far as international cooperation, I think in some areas in standardization it will be difficult, in some areas not so difficult. A few years ago we had an OECD group that started to recommend common standards, at least common test conditions, for testing iodine adsorbents (temperature, humidity and so on). I think most European countries went along with the recommendations. In the US, however, we still have about fifteen different test conditions and that's just on Tuesdays; on Wednesdays we have a few more. And some of these are realistic and some of them have absolutely nothing to do with reality. When we are talking about international standardization it also means that we have to give up some of our stupid US standards here, and accept some of the foreign ones that are good, and vice versa. You do not realize how difficult it is until you start supplying the same material to different countries, and you look at the test methodologies and it's relatively easy to find that one of them is really, really good and easy to consistently perform, you don't need two lawyers to interpret it, you don't need a lawyer for yourself and one for the regulatory agency. It's clearly written, it's readable and that's the one that really should be adopted, instead of everybody trying to come up with a slightly different one, often without understanding the basic technical concepts on which the particular test procedure is based. So this is just a little additional rambling relating to standards and how we are interpreting some of the wording of these standards and codes. And I hope you forgive me for the repetition that you heard in some areas.