ON-SITE INVESTIGATION OF

INCINERATOR EMISSIONS IMPACTING ON

THE NAVAL AIR FACILITY AT

ATSUGI, JAPAN

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Executive Summary

NAF Atsugi neighbors four (4) Japanese owned and operated incinerators south of the water treatment plant. These units burn municipal solid waste, liquid and solid industrial waste, solid commercial waste, and construction debris. It is also alleged that pathological waste is burned in one of the units. Three of the units are operated without emission control equipment. The fourth unit has a scrubber that appears to be deteriorated and nonfunctional.

This report details our observations and conclusions. Our conclusions are based on the operation, waste stream, and known products of combustion from similar processes. A detailed report will follow when laboratory analyses of ambient air samples are completed.

Industrial wastes and plastics contained in municipal solid and commercial waste create a "witches brew" of toxic emissions when incinerated at insufficient temperature, combustion time, turbulence, or oxygen. Incineration of wastes containing heavy metals, acids, and caustics requires use of emission control equipment. Our observations indicate that procedures used at the incinerator site do not provide complete combustion. This probably results in highly toxic organic emissions, e.g. dioxins, dibenzofurans, and polycyclic aromatic hydrocarbons. In addition, the units appear to be uncontrolled, which allows emission of heavy metals and inorganic acids from the industrial wastes. If our initial hypotheses are correct, these emissions may pose a health hazard to the entire area and must be dealt with as such. These types of emissions are potent toxins. Most of the compounds are carcinogens or suspected carcinogens. Some of the compounds are also mutagens, or teratogens. Overtime heavy metals will accumulate in the human body to toxic levels.

Liquid industrial wastes are poured onto the solid waste piles prior to burning. The piles appear to be on bare earth with no provision to prevent toxic runoff into the nearby stream or into the ground water. This is a severe environmental threat to the Japanese community.

Unfortunately, short term monitoring may prove to be insufficient to substantiate the existence of any long term exposure problem. Unless we find ambient chemical concentrations that approach emergency response action levels, long term monitoring will probably be required to assess the health risk to nearby personnel.

In the short term, the Japanese operators can improve the situation markedly by repairing the incinerators and operating them properly. Installation of some simple pyrometers will help the operators maintain temperatures required to minimize toxic emissions. Long term solutions will require upgrade of the incinerators and installation of high efficiency control equipment.

CERTIFICATION PAGE

A. I, Barry Hickenbottom, as team member am responsible for all data.

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B. I, David Carpenter, certify that all testing details and conclusions are accurate and authentic.

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BACKGROUND

A Japanese owned and operated industrial incinerator operation is located south of the NAF Atsugi water treatment plant. The incinerators are located approximately 100 yards outside the NAF fence. Located in a small valley, south-southwest to south-southeast winds blow the incinerator plumes up the valley onto the base. Under these conditions, much of NAF is fumigated by noxious fumes. Personnel at the facility complain of eye irritation, nausea, and respiratory discomfort when exposed to the plumes.

RADM Best, Commander, Fleet Air Western Pacific, concerned for personnel health and safety, requested assistance from the Pacific Division, Naval Engineering Facilities Command (PACDIV). PACDIV asked us to monitor emission ground level concentrations and determine if a health risk exists. PACDIV and we cautioned that short term monitoring might not be able to "prove" that a problem exists. Unless concentrations approached ten (10) per cent of the permissible exposure limit (PEL) for any single species, long term monitoring would be required to assess health "risk." If concentrations are close to or exceed ten (10) per cent PEL, then emergency response is required to protect base occupants.

The best procedure to determine health risk is actual source emission measurements in conjunction with mathematical modeling to determine worst case ground level concentrations. Unfortunately, as the incinerators are Japanese owned and operated, we are not allowed to measure in situ stack emissions. Also, much of the problems appear to be caused by poor operation, which could be temporarily improved during a source emission test. Therefore, the only practical way to assess risk or need for emergency action is ground level air monitoring.

PROCEDURES

High volume filter and Polyurethane Foam
Method TO4

XAD-2 adsorption
Method 18

Charcoal adsorption
Method 18

Midget impingers and water
Method 116

Formaldehyde tubes
Method 116

Observation
Method 9

OBSERVATIONS

The incinerator complex houses four (4) individual units. We numbered the units one (1) through four (4) from South to North.

The first unit is inside a building with only the stack and vent piping visible. Although we cannot be sure, the absence of a solid material feed system suggests that this unit is used to incinerate liquid waste. During our observations, tank trucks were observed tipping at the complex.

The second and third units appear to be identical two chamber incinerators mass fed from a hopper. Both units have short refractory lined stacks. Waste is dumped into a tipping pit, picked up with a manually controlled claw and dropped into the feed pits. Large items are manually removed and thrown into the units when the hoppers are low. Occasionally, flames were observed coming from one of the stacks. These units also emit most of the dense black or dense white smoke.

The fourth unit appears to be identical to units two and three except that its stack has been replaced with a four duct breech connected to a single breech that goes to a scrubber and what appears to be a four (4) cyclone mist eliminator. This incinerator also has two (2) induced draft (ID) fans, presumably to offset the pressure drop of the scrubber and cyclones. A taller stack, estimated to be about 100 feet, follows the scrubber.

A feed pit for the fourth unit is not visible from either the air or from the fence line. However, since the incinerator design appears to be identical to Units 2 and 3, we assume that Unit 4 is stoked in a similar manner. Unit 4 occasionally emits dense black smoke, approaching Ringelmann 5 (100% opacity), for 1 to 2 minutes. It emits white smoke, averaging about 40% opacity, almost continuously.

Observation during our monitoring period leads us to conclude that the scrubber is either not operated, not operated properly, or is seriously malfunctioning. Judging from the corroded appearance of the equipment, we guess that the scrubber internals have deteriorated from exposure to the stack gases.

Units 2, 3, and 4 are severely corroded. The stack tops of units 2 and 3 are badly eaten away.

We observed tank trucks tipping in front of the Unit 4 scrubber. We believe that Unit 4 is directly firing liquid industrial waste along with the solid refuse.

Type of Waste

We observed five types of waste being burned: municipal solid waste (MSW), liquid industrial waste, solid industrial waste, solid commercial waste, and construction debris. Although we did not observe any during our brief monitoring period, we repeatedly heard allegations that the complex burns pathological waste. Of the observed waste types, the liquid and solid industrial wastes are cause for the most concern. If the allegations that pathological waste is also being burned are true, we would be gravely concerned since the units do not appear to be adequately designed or operated to destroy pathogens found in this type of waste.

Liquid industrial waste is delivered in tank trucks and in drums. The drums are picked up with a five (5) finger claw and crushed over the piled waste. The liquid contents drain into the waste. Since the operation is on bare earth, ground water contamination is undoubtedly a problem. The wet waste is then transported to the tipping pit.

Solid industrial and commercial waste is delivered in cardboard boxes, and on flatbed stake trucks. Boxes that broke open appear to be filled with plastic waste. However, most of the boxes were sealed with no discernible markings; we have no way of knowing their contents. The stake trucks delivered loose wood and plastics.

Mass stoking the units results in over-firing indicated by the dense black smoke followed by the white smoke. Furnace temperature and residence time appear too low and too short to adequately burn the waste. The resultant emissions appear to be carbonaceous particles (the black smoke) and condensed partially pyrolyzed materials.

Municipal Solid Waste (MSW): Garbage trucks deliver MSW. MSW has a distinctive odor which is noticeable on base when the plume is not fumigating the area. Although unpleasant, the odor is not injurious.

MSW has little odor when burned properly. Except for metals and halogens, MSW mass burn incineration emissions are fairly low and easily controlled with particulate collection device such as a fabric filter or an electrostatic precipitator. Halogens form strong acids that corrode the incinerator and condense in the plume. These acids are injurious to both animal and plant life.

Proper MSW emission control requires at least one (1) second exposure to a temperature greater than 1800°F in a turbulent atmosphere with at least three (3) to four (4) per cent oxygen content. If any one of these conditions is absent, plastics in the MSW will partially pyrolyze to dioxins and dibenzofurans. Additionally, polynucleaic aromatic hydrocarbon

compounds/polycyclic aromatic hydrocarbon compounds (PNA/PAH) such as pyrenes, and other toxic organic chemicals, e.g. aldehydes, will be formed when combustion is incomplete.

Industrial Wastes: Industrial waste streams are frequently a "witches brew" of toxic chemicals. Frequently they include heavy metals in solvents, acids, or bases from cleaning, machining, and plating operations. Industrial waste usually contains a high content of plastics. However, it is the heavy metals that are of great concern. Heavy metals represent a long term toxic environmental threat. They are easily ingested, cumulative in animals, and persist in the environment. Incineration has no effect on the metals other than to change their chemical form. Therefore, heavy metal emissions must be controlled either by source segregation or by collection in a high efficiency particulate control device. California now requires use of devices with greater than 99% collection efficiency for some metals.

Plastics are fairly well destroyed by incineration. The halogens in plastics form halogen acids, mainly hydrochloric, which are easily removed by scrubbing or rapidly dissipated with a stack tall enough to meet toxic ground level concentrations limits of approximately 0.5 ppmv. Neither exists at the incinerator operation. A tall stack may impact airfield operations.

Plastics represent another threat. Like MSW, plastics must be incinerated above 1800°F in a turbulent atmosphere with at least three (3) to four (4) per cent oxygen content. If any one of these conditions is absent, plastics in the industrial waste will partially pyrolyze to dioxins and dibenzofurans. PNA/PAH, and other toxic organic chemicals are formed when combustion is incomplete.

Other solid industrial wastes, such as cardboard, paper, and wood do not represent a threat when properly burned. Being primarily organic, they burn easily when fired with sufficient oxygen. However, over stoking causes partial combustion and the formation of soot and toxic organic compounds.

The one exception for paper and wood is the production process used to make the product. Paper frequently is printed with colored inks that use heavy metals for "brilliance." Although very small in quantity, emissions from these inks are the same as emissions from other heavy metals. Similarly, wood can be treated with heavy metals or phenolic compounds to prevent rotting or termite infestation. When burned this wood will emit the metals. If not burned properly, e.g. 1800°F etc., the phenolic compounds will produce toxic emissions.

Commercial Waste: Commercial waste generally consists of cardboard, paper, and plastics. Again, if properly burned, e.g. 1800°F etc., the emissions will not generally be toxic. However, plastics will produce halogen acids which require control either by a scrubber, dilution among other waste emissions, or a tall stack.

Construction Debris: Debris from demolition and site clearing generally consist of organic matter - mainly wood or wood products. If properly burned, e.g. 1800°F etc., the emissions will not generally be toxic. The one exception is treated lumber, which was previously discussed in the "Industrial Wastes" section.

Pathological Waste: Pathological waste consists of contaminated "sharps," bandages, plastics and glass, and bodily waste. It is highly toxic and must be incinerated in a carefully controlled environment (usually a multi-chamber unit with supplemental fuel) with a high efficiency particulate control device. Improper handling, storage, or burning of the waste can lead to wide spread infectious problems. This is probably impacts the incinerator operators and ground level water quality rather than for base occupants.

Physical Observations: The area from the golf course 7th tee to the west side of the water treatment plant is frequently fumigated by either a looping or fumigating plume. When this occurs the area appears to be in a gray fog. There is a noxious odor other than the normal odor of MSW incineration. Interviews with activity personnel confirmed that the skin of sensitive people (generally those with light hair color, fair complexion, and blue eyes) begins to burn where perspiration collects in beads or on clothing (forehead, cheeks, upper lip, shirt collar, etc.) Eyes burn. A foul taste is noticed in the mouth. After a few minutes exposure, individuals complain of nausea, upper respiratory tract discomfort, and chest tightness. Exposure longer than about 20 minutes to the dense "fog" results in coughing, difficulty in breathing deeply, dizziness, and fatigue.

We frequently observed the plume fumigating as far as the Bachelor Officers Quarters, the Navy Exchange, and the area of the control tower. It is probable that over time, all parts of the base are exposed to the effects of these incinerators.

The odor, eye irritation, and upper respiratory tract discomfort suggests the presence of aldehydes. The skin irritation and respiratory stress suggest the presence of acids.

PERSONAL OBSERVATIONS

We were mentally unprepared for any thing this bad. After initial discussion with others more familiar with the incinerator operation, we erroneously concluded that the objectionable odor from the handling and combustion of MSW was the source of complaints. However, when we arrived and saw the stacks of drums, the liquid industrial waste being poured onto the waste piles, the dense black and gray smoke, etc., we were astounded that anything this bad could have persisted for so long. Based on our experience in less acute operations we feel strongly that base occupants, residents in the area, the ground water, even the pigs on the co-located farm are being exposed to a brew of toxic chemicals.

Each of us has almost 20 years of air pollution control experience and neither of us has seen anything this bad. However, a short term test may not be sufficient to identify all toxic substances which are emitted. Short term testing is certainly insufficient to assess the health risk to activity personnel. Long term testing will probably be required. For now, professional observations and anecdotal reports are probably the best assessment of environmental impact.

We have been exposed to numerous toxic gases in our work. Frequently we work on boilers and industrial shops where we are exposed to oxides of sulfur and nitrogen, inorganic acids, and hydrogen sulfide. We have developed sensitive noses to these gases and mists and to the odor of burning and stored MSW. We have worked on MSW incinerators since 1976. However, there are so many constituents in these incinerator emissions that it has not been possible for us to determine individual components with our olfactory capabilities. We have not detected the smell or taste of oxides of sulfur or hydrogen sulfide.

On a previous job, Mr. Carpenter was exposed to sulfur dioxide for several hours. He experienced pneumonia like symptoms for about 24 hours and coughed up blood. He experienced similar respiratory symptoms (without the bloody cough) on this job after exposure to several hours of ground level fumigation on Tuesday, 7 August 90. The episode caused by this incinerator was not from exposure of sulfur dioxide.

DISCUSSION

As previously stated, the emissions appear to be a complex mixture of toxic inorganic gases, volatile and semi-volatile organic compounds, toxic metals, condensed organic compounds and inorganic acids from partially combusted waste.

Both black and white smoke are emitted. Both can be injurious to human health and to the environment. Fine carbonaceous matter (less than 10 microns in diameter) in the black smoke adsorbs toxic chemicals in the plume and transports them deep into the respiratory system. Condensing vapors in the white smoke can be absorbed through respiration and skin contact.

Because of the way the units are fired, over stoked - always smoking, and from the waste stream, industrial and high plastics content, we believe that dioxins, dibenzofurans, and other highly toxic organic compounds are being formed.

There are no generally accepted long term exposure limits for dioxins. The Occupational Safety and Health Administration (OSHA), National Institute of Occupational Safety and Health (NIOSH), and the American Conference of Government Industrial Hygienists (ACGIH) have different exposure limits for dioxins. OSHA and NIOSH have no limits for dibenzofurans. PNA/PAHs have various limits depending on the species. Dioxins, dibenzofurans, and PNA/PAHs are highly toxic and listed by NIOSH as "potential occupational carcinogens." In addition these compounds are suspected mutagens (causing cancer from mutation of normal cells during the division process and causing birth defects by causing mutations in the production of sperm or ovum) and teratogens (causing birth defects and miscarriage from damage to fetal or embryonic cells). Target organs are liver, kidneys, prostate, blood, skin, eyes, and respiratory, central nervous, and cardiovascular systems.

In our opinion, dioxin exposure should be limited to only highly controlled industrial situations where these species are either used in a process stream or occur as a byproduct of the operation. In these situations, workers and industrial hygienists know exactly the species being dealt with and know what precautions to use. Exposure to the general population is intolerable.

Heavy metals: Observation of the waste stream leads us to conclude that there is a very high probability that heavy metals are being emitted. We suspect that arsenic, cadmium, chrome, and lead are likely being emitted. Mercury may also be emitted. Without knowing the metal species and content in the waste being incinerated, metal emissions in the plume are difficult to predict.

Target organs are liver, kidneys, skin, gastrointestinal tract, gingival tissue, and respiratory, lymphatic, and cardiovascular systems. Again, uncontrolled emission of these materials is unacceptable. Coincidentally, some of the worst episodes of heavy metal poisoning have occurred in Japan. The Japanese should be particularly sensitive to uncontrolled releases of heavy metals.

Aldehydes: Plume taste and odor reminds us of aldehydes. Incinerators frequently emit aldehydes from partial pyrolysis of organic waste and solvents. Since excess air is required to form aldehydes, their formation would only occur when white smoke is being emitted - which is the majority of the time. Aldehydes are suspected "potential occupational carcinogens" and attack the respiratory system, eyes, and skin. Unfortunately, aldehydes are also fairly common in the environment. Similar to dioxins, the health community disagrees on the allowable exposure to aldehydes. NIOSH recommends a 15 minute ceiling of 0.1 ppmv for formaldehyde, which is probably easily exceeded by a game of golf or practice on the pistol range with southerly winds.

PNA/PAHs: Potent carcinogens and mutagens formed by incomplete combustion.

RECOMMENDATIONS

Source emission test (Japanese)

Long term (12 month) monitoring to find out whether or not personnel are exposed to toxic emissions (Navy)

Ground water analysis - possible remediation site (Japanese)

Soil analysis - possible remediation site (Japanese)

Fix or shut down and remediate (Japanese)

Immediate Improvements

Stop over firing the units - stay within manufacturer's design rating.

Inspect units and make needed repairs.

If two stage units, use supplemental fuel to maintain second chamber temperature above 1800°F.

Install pyrometers in the furnaces. Operate so that furnace temperature is maintained. Develop load rate versus temperature curves to help operators know loading limits.

Inspect scrubber and make needed repairs.

Use Unit 4 with scrubber operating as the main incinerator. Limit use of Units 2 and 3.

Monitor wastes. Wastes that have heavy metals, acids, or caustics, burn only in Unit 4 with the scrubber operating.

Long term improvements

Build containment areas for waste piles to prevent ground water and stream contamination.

Add new large modern incinerator to accommodate waste stream. Combine the operation with the tire burning incinerator (across the fence from the bunkers) so that no uncontrolled incinerator operations exist. If that is not feasible, then the tire burner requires replacement with a two chamber or integral furnace type unit to completely combust the waste.

Add high efficiency particulate and acid gas controls to Units 1, 2, and 3. Upgrade controls on Unit 4.

Model emissions to determine emission hot spots. Increase stack height to lower hot spot concentrations below accepted ambient air concentrations or emergency action levels if no applicable ambient standards exist.

Perform annual source emission test and regular unannounced inspections to ensure that incinerator operators use good operation practices and that emission control systems and temperature monitors are adequately maintained.

CONCLUSION

One heck of a problem - a definite health issue.

There is a strong potential for adverse health effects on base residents because of the incinerators. Because of the wide variety of potent toxins produced by incineration, and the poor operation of these units, further study should be done to assess the risk to base residents. The laboratory results which will follow this report are the first step in that direction.

REFERENCES

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