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PFAS Contamination from US Military Facilities in Mainland Japan and Okinawa

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Abstract: *Persistent in the environment, bio accumulative in animals and humans, and toxic at low levels, per- and polyfluoroalkyl substances (PFAS) are associated with serious health problems including cancers, hormone imbalance and harm to the immune system. One of the most widespread uses of PFAS has been in aqueous film forming foam (AFFF), a firefighting product linked to widespread contamination at Department of Defense (DoD) installations in the United States. Whereas the DoD has investigated – and in some cases remediated – this problem within the United States, in Japan, host to 78 US military facilities, there has been no such transparency. Civilian checks near DoD bases, notably in Okinawa Prefecture, have detected elevated PFAS levels in waterways, soil, residents' blood and the drinking water supplied to 450,000 people. But US military officials insist there is no proof that its bases are responsible for the environmental problems and they have denied requests from local authorities to conduct on-base checks. This article assesses the most serious environmental threats to Japan and Okinawa associated with PFAS and other chemicals originating at US bases. One method to overcome these obstacles to understanding the threat is the US Freedom of Information Act (FOIA). Internal reports obtained by the author under FOIA reveal that US military operations have been polluting Okinawa and mainland Japan with PFAS via three principal pathways: (1) firefighter training; (2) accidental leaks of AFFF; and (3) disposal of AFFF. Contamination dates from the 1970s and is ongoing; PFAS has spread into neighboring communities, impacting drinking water supplies, and the problem has been exacerbated by negligent handling and disposal of AFFF stocks. This paper concludes with a discussion of how the problem can be further researched and ways to remediate both the contamination and the opacity of US-Japan environmental agreements which allow the US military to suppress information about incessant environmental damage.*

PFAS: An Overview

Per- and polyfluoroalkyl substances (PFAS) are a group of approximately 5000 chemicals, the most widely-researched of which are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Containing strong chains of carbon and fluorine atoms, PFAS are resistant to heat, water and oil; they have been used in industry – notably textile, metal-plating and semiconductors – and can be found in household items including nonstick frying pans, waterproof clothes, and wrappings for greasy foods. One of the most widespread uses of PFAS has been in the manufacture of aqueous film forming foam (AFFF), a firefighting chemical developed by 3M and the US Navy in the 1960s. Due to the ability of AFFF to quickly extinguish fuel fires, the US Department of Defense (DoD) mandates use of AFFF in vessels, hangar sprinkler systems, fuel farms and emergency vehicles.[1] AFFF has also been used at civilian airports in the United States and around the world. AFFF contains

numerous PFAS with PFOS and perfluorohexane sulfonate (PFHxS) among the most prevalent.[2]

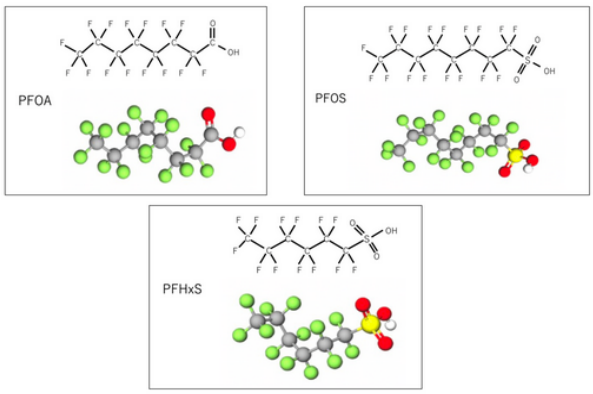

Figure 1: Depending on their number of carbon atoms, PFAS are categorized as long-chain (such as PFOA and PFOS which both have eight carbon atoms) or short-chain, for example PFHxS which contains only six carbon atoms.

For decades, 3M suspected PFAS were harmful to animals and could accumulate in the human body; since the 1980s, the military, too, began to become aware that AFFF was hazardous.[3] But service members and the public were not alerted to the risks and large volumes of the foam were released into the environment during sprinkler system checks and training exercises. In 2000, 3M announced it would halt the production of PFOA and PFOS – and it ceased manufacturing AFFF. In 2006, the EPA announced the "PFOA Stewardship Program" under which the key manufacturers would phase out production of some PFAS.[4] In the United States, manufacturers had reduced their PFOA and PFOS usage and emissions by 95% by 2010, and by 2015, they had halted them entirely.[5]

In Japan, PFAS have been widely used by civilian industries and contamination has been detected in heavily-industrialized areas such as Osaka and Tokyo. Civilian stockpiles of PFAS firefighting foam, for example at petrochemical plants, have been estimated to surpass 13,000 tons and the Japanese Self Defense Forces possess 400,000 liters of AFFF.[6] In 2018, Japan halted the domestic production and import of PFOS under the terms of the Stockholm Convention on Persistent Organic Pollutants; currently it is moving to apply the same controls to PFOA.

In 2015, the US military began replacing its stocks of legacy AFFF with PFOS-free foams – but the new formulations still contain other PFAS, including PFOA.[7] In 2018, the DoD released data on PFOA and PFOS contamination at its facilities within the United States, and overseas in Belgium, Honduras and South Korea – but it did not include any information on its 78 facilities in Japan.[8]

Research into the health risks of PFAS has been slow due to the failure of manufacturers and the military to make public their studies during the twentieth century – but since 2000, the number of investigations has increased.[9] Today, the Agency for Toxic Substances and Disease Registry (ATSDR) links PFAS exposure to harm to the body's natural hormones and immune system, increased cholesterol levels and elevated risk for some cancers.[10] Particularly susceptible to PFAS are the young who can be exposed before birth through the umbilical cord and then as infants through breast milk. Potential health problems for children include lower birth weight, reduced vaccine response and delayed mammary gland development.[11]

Due to their strong carbon-fluorine bonds, PFAS are practically indestructible in nature and experts estimate they will last in the soil for thousands of years.[12] Such persistence has led them to be nicknamed "Forever Chemicals"

in the United States.

The prime route for human exposure to PFAS is drinking water, so national and local authorities' efforts have focused on reducing such levels. In 2009, the US Environmental Protection Agency (EPA) announced a short-term drinking water advisory, applicable for people consuming contaminated water for only several months, of 400 ppt for PFOA and 200 ppt for PFOS; no other PFAS were included. As understanding of the risks of PFAS became clearer, in 2016 the EPA established a lifetime health advisory of 70 ppt for PFOA and PFOS combined – a limit which provides for the consumption of two liters of contaminated water a day. In 2018, the ATSDR recommended maximum levels of approximately 11 ppt for PFOA and 7 ppt for PFOS – but the federal government has still not introduced an enforceable legal limit.[13] In the United States, individual states have introduced their own standards which have been lower than the EPA's and encompass more PFAS. In April 2020, Japan implemented a drinking water advisory of 50 ppt for PFOA and PFOS combined but, as in the United States, it features no legal provisions and only applies to two substances. The following month, the Japanese government applied the same non-enforceable level of 50 ppt to rivers and groundwater.

Japan: The US Military and the Environment

Under the 1960 Treaty of Mutual Cooperation and Security Between the United States and Japan (aka AMPO), the US maintains a military presence in Japan and agrees to defend the country if it is attacked. Today in Japan, there are 78 US military facilities with their headquarters at Yokota Air Base, Tokyo; the southernmost prefecture, Okinawa, hosts 31 installations, notably two large air bases, Marine Corps Air Station (MCAS) Futenma and Kadena Air Base, the largest United States Air Force (USAF) installation in the Pacific region. In Japan, including Okinawa, there are an estimated 35,000 service members and Japan pays approximately $1.8 billion of the costs of hosting the US military presence.[14]

Throughout Japan, US bases have caused high-profile environmental problems. In the 1950s, fuel leaks from Tachikawa Air Base, Tokyo, contaminated the drinking water of almost ten thousand residents and radiation was detected near the nuclear-powered submarine USS Swordfish in Sasebo harbor, Nagasaki Prefecture, in 1968.[15] Okinawa, a US military colony between 1945 and 1972 and the center of the US military presence to the present, served as the key staging post for wars in Korea and Southeast Asia; accidents there included a misfired nuclear missile in 1959, a leak of nerve agent in 1969 and a large spill of hexavalent chromium in 1975.[16]

Whereas in the United States, the federal government has taken action (albeit limited in scope) to ensure that DoD facilities abide by environmental laws and conduct remediation work in a transparent way, in Japan, bilateral agreements permit the US military to police itself.[17] Under the Japan-US Status of Forces Agreement (SOFA) – signed at the same time as AMPO and never formally revised in the six decades since – the United States controls access to installations and refuses entry to national and local authorities seeking inspections. In addition, on-duty service members are exempt from prosecution for damage to Japanese property and the military is not required to remediate contamination on land returned to civilian usage.[18] In recent years, high levels of lead, dioxin and polychlorinated biphenyls (PCBs) have been discovered on returned bases; as of 2018, Japanese taxpayers had paid 12.9 billion yen ($120 million) for remediation of former military land on Okinawa alone.[19]

Matters arising from the US military presence in Japan are handled by the Japan-US Joint Committee, an organization exempt from public oversight whose decisions are rarely revealed. The committee guides the contents of the Japan Environmental Governing Standards (JEGS), a document which establishes environmental protocols within military installations. First drawn up in 1995, and periodically updated, most recently in 2018, JEGS do not create any enforceable rights against service members or the US government vis-à-vis environmental damage. JEGS list hazardous substances which require reporting when released in an accident; PFOS was added in 2018 but PFOA, PFHxS and other PFAS still have not been included.[20] The extent to which the DoD allows commanders in Japan to self-regulate is evident in USMC accident guidelines (obtained by the author via the US Freedom of Information Act (FOIA)) which order Marines *not* to inform Japanese officials of "non-emergency and/or politically sensitive incidents."[21]

Lack of environmental accountability has created resentment in Japan, particularly on Okinawa where elected officials have repeatedly demanded that SOFA be revised. In 2012, this prompted the Central Intelligence Agency to warn US policymakers that, "Okinawan support for environmental preservation presents challenges to alliance managers… Okinawa may pressure Tokyo to expand environmental guarantees for base land – including revision of SOFA provisions on environmental remediation."[22]

Despite Okinawans' demands, the United States and Japan have never revised SOFA. One cosmetic reform was made in 2015 following the discovery of 108 barrels of defoliants on former military land near Kadena Air Base. The agreement, called "Cooperation Concerning Environmental Matters," granted Japanese authorities the right to *request* on-base checks in the wake of a hazardous spill or prior to the return of military land.[23] But the decision whether to allow such access remains with the DoD and, as discussed below, the first such permission was only granted in April 2020.

PFAS contamination on Okinawa

Okinawa Prefecture consists of approximately 55 islands with a combined population of 1,450,000, the majority of whom live on *Okinawa hontou*, (Okinawa main island). There are 31 DoD facilities in the prefecture, occupying approximately 15% of the main island[24]; the prefecture's key industries include tourism (contributing 26% to the economy) and government services (15%) with the military presence contributing approximately 5%.[25] Okinawa possesses no large industries associated with the manufacturing or usage of PFAS.

Okinawa's main source of drinking water is Chatan Water Treatment Plant in the center of the main island which provides drinking water to 450,000 residents and tens of thousands of tourists, US service members, their dependents and civilian contractors. Located adjacent to Kadena Air Base, the plant draws its water from rivers running through and around the base as well as approximately 20 wells within or near the installation known as the "Kadena Well Field"; these wells tap into an aquifer which lies beneath the base.

For prefectural officials, the first sign their island had a PFAS problem came in 2008 when PFOA and PFOS levels of 1870 ppt were detected from one of the wells in the Kadena Well Field; the Prefecture halted using water from the well but continued to draw water from the others.[26] Most residents of Okinawa first learnt of PFAS contamination in 2016 when the Prefecture announced it had detected elevated levels of PFOS in rivers near the installation. The Dakujaku River, which runs through the base above and below ground, contained combined levels of PFOA and PFOS as high as

1,379 ppt and the drinking water supplied by Chatan Water Treatment Plant peaked at 120 ppt.[27] Tests on fish from the Hija River basin revealed PFOS levels from 22 to 111 parts per billion (ppb) far exceeding Japan's national average of 0.09 ppb.[28]

Following these discoveries, prefectural officials expanded their PFAS surveys, discovering contamination in groundwater and springs located downhill from MCAS Futenma. At Chunnaga spring in 2018, for example, PFOA/PFOS levels measured 2000 ppt and Mendakarihiga spring was contaminated at 650 ppt.[29] Although such springs are not a direct source of drinking water, residents use them to irrigate crops and, for centuries, the springs have been venerated as sacred sites.[30] Downhill from MCAS Futenma in the Ooyama district, PFAS has been detected in the soil of farmers' fields at 11,436 ng/kg, higher than any level ever recorded by the Japanese government.[31]

**Figure 2: The author at Azayara Shiriga in December 2019;
adjacent to Kadena Air Base, the spring has been contaminated with PFOA/PFOS at 1140 ppt.**

In response to these discoveries, in 2019, researchers from Kyoto University led by Emeritus Professor, Koizumi Akio, conducted blood checks on residents living in Ginowan City which hosts MCAS Futenma and receives water from Chatan Water Treatment Plant. Residents' blood contained levels of PFOA of 3.3 ng/mL (more than double the national average), PFOS levels were 13.9 ng/ml (four times the national average), and PFHxS were 16.3 ng/mL (53 times the national average). All levels were higher than those of residents in Nanjo Town, Okinawa Prefecture, whose water is not supplied by the Chatan plant.[32] The findings prompted Koizumi to re-check historic samples at the Kyoto Biological Specimen Bank. Taken from farmers in the Misato area near Kadena Air Base in 1981, Koizumi's newly-conducted tests showed average levels of PFOA at 25.6 ng/mL, PFOS at 47.6 ng/mL and PFHxS at 25.9 ng/mL.[33] The data indicates that residents have been exposed to PFAS for four decades or longer.

In October 2019, prefectural officials detected PFOS levels of 300 ppt in water draining from USMC Camp Hansen, northern Okinawa; follow-up checks the next month confirmed PFOS contamination at three locations reaching 94 ppt.[34]

In 2018, the US military released statements acknowledging both Kadena Air Base and MCAS Futenma possessed fire suppression systems equipped with AFFF containing PFOS.[35] But DoD officials have asserted that it is impossible to confirm its installations are the sources of the contamination detected in off-base communities. In 2019, USMC spokesperson Captain Michael Hopkins told Stars and Stripes, "It would be inappropriate to speculate where the presence of PFOS and PFOA in off base waterways originated."[36] The military has repeatedly denied requests from Okinawan officials under the Cooperation Concerning Environmental Matters for on-base checks; notably, in 2016, the USMC told the

Japanese government's Okinawa Defense Bureau, "Since PFOS is not a regulated substance in the US and Japan, therefore there is no point in responding to additional questions or holding a meeting for which there are no established standards nor regulations."[37] Between 2016 and 2020, the Japanese government also resisted demands by Okinawans to establish a drinking water limit for PFAS. With no such standards forthcoming, the Okinawa Prefectural Government adopted the US EPA advisory of 70 ppt.

Okinawa Prefecture has installed activated carbon filters at Chatan Water Treatment Plant to lower levels in drinking water; from an average of 44 ppt in 2015, combined PFOA/PFOS levels had fallen to 23 ppt in 2019 – lower than the EPA's recommended 70 ppt but still exceeding levels recommended by the ATSDR and some individual US states.[38]

Using FOIA to investigate US military PFAS contamination in Japan

FOIA is a system whereby the public can request access to federal government records, including those created by DoD facilities overseas. Documents obtained by the author via FOIA have disclosed unreported military contamination, including pollution from Vietnam War retrograde chemicals at Camp Kinser, Urasoe City, 240+ environmental accidents at Kadena Air Base between 2010 and 2015, and the disposal of at least 120,000 liters of radiation-contaminated water at mainland bases following the meltdowns at the Fukushima Daiichi nuclear power plant in 2011.[39] FOIA requests have been instrumental in revealing how military operations have contaminated Okinawa and mainland Japan with PFAS.

Okinawa

According to FOIA-released records, PFAS contamination has taken place in the prefecture in three main ways: (1) firefighter training; (2) accidental leaks of AFFF and; (3) AFFF disposal.

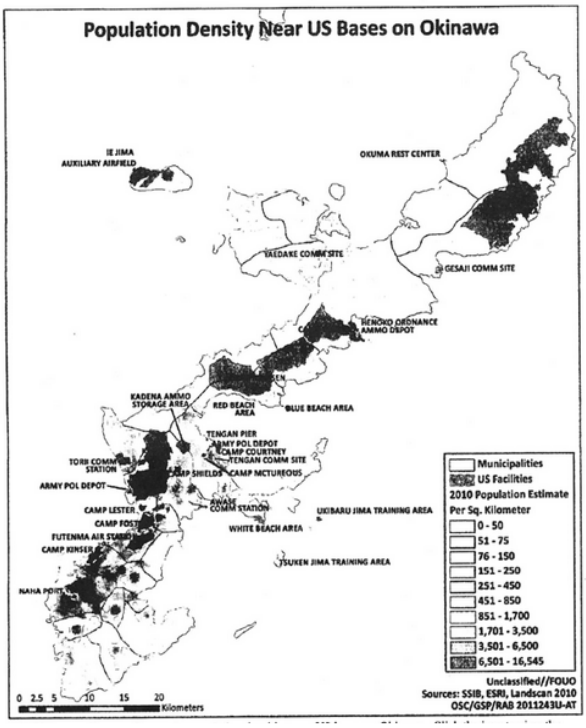

Figure 3: Main US military installations on Okinawa (CIA)

1. Firefighter Training

Most air bases have a fire training area where firefighters fill a pit with water and aviation fuel then set it alight to practice extinguishing techniques; such training can involve thousands of liters of foam. In the United States, surveys of current and former fire training areas have revealed severe PFAS contamination penetrating the ground and spreading in plumes for several kilometers.[40]

According to reports from the US House Committee on Armed Services, during the 1970s and '80s, the fire training area at Kadena Air Base was not equipped with any pollution control devices.[41] Japanese government archive photographs from this period show that the area was located approximately 50 meters west of the Dakujaku River. USAF maps reveal water flows from the fire training site towards the river and three of the wells which supply water for the islands' residents.[42] In June 2020, test results announced by the Ministry of the Environment revealed that the Dakujaku River was contaminated with PFOS at 1462 ppt, the highest in the nation.[43]

In the late-1980s, it appears the USAF halted use of the fire training area and today an aircraft maintenance facility sits atop the former site. However, continued high levels of PFAS in the vicinity suggest the ground is contaminated and that past remediation efforts – if any were performed – failed to remove affected soil. Elevated levels in nearby wells raise concerns the aquifer may have become polluted; between 2013 and 2019, combined levels of PFOA and PFOS reached more than 800 ppt.[44] As of August 12, 2020, the USAF had not responded to requests for comment nor has the military granted permission to Japanese or Okinawan officials to inspect the area.

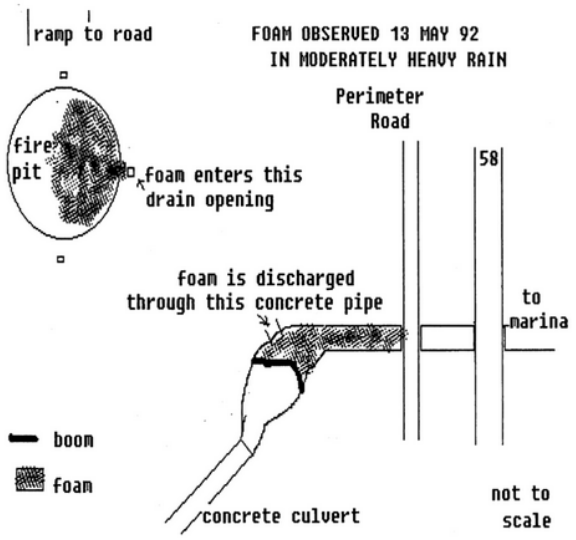

Figure 4: A diagram from the 1992 USAF survey shows Kadena Air Base allowed firefighting foam to leak from its fire training area into nearby sea. (USAF via FOIA)

In 1988, the USAF constructed a replacement fire training area in another part of Kadena Air Base. Here, too, there were problems. In 1992, inspectors from the USAF Armstrong Laboratory noted AFFF was flowing from the site into the sea. The report noted a "two-foot (60 centimeter) thick foam layer" in one culvert leading off the base; the drain emptied into Kadena Marina, an area popular for fishing and swimming. The report's author stated the release of the foam violated USAF environmental policies but military officials did not know if it broke local standards because their translations of Japanese regulations were "old and unclear."[45] According to FOIA-released reports, USAF checks at the fire training area in 2017 detected PFOS contamination of 500ppt.[46] Local government surveys on off-base wells in the vicinity have shown PFOA/PFOS levels reaching 2000 ppt.[47]

At MCAS Futenma, tests conducted in February 2016 at its firefighting training pit revealed

PFOA contamination of 1,800 ppt and PFOS contamination of 27,000 ppt.[48] According to a statement issued by the USMC, the Marines have only been using water for firefighting training exercises since March 2016[49] but surveys conducted by Okinawa prefecture at off-base Chunnaga spring, situated downhill from the training area, show ongoing contamination. In its summer 2016 survey, Okinawa Prefecture detected combined PFOA/PFOS levels of 1300 ppt at the spring; these had dropped to 880 ppt by summer 2017 but rose again to 1000 ppt by that winter. This suggests that past AFFF usage has penetrated the ground, causing persistent contamination.[50]

Figure 5: Marines conduct a fire training exercise at MCAS Futenma in 2015. (Department of Defense).

2. Accidental leaks

According to FOIA-obtained reports, between 2001 and 2015, Kadena Air Base inadvertently released at least 23,000 liters of various firefighting foams, including those containing PFAS. In 2012, for example, a Japanese firefighter set off a sprinkler system in an accident that leaked thousands of liters of foam. In 2015, a drunk Marine trespassed into a hangar at the same base and, in an act described as "vandalism," set off the sprinkler system, releasing large volumes of foam, some of which left the base. In several of the accident reports, the type of foam involved was insufficiently described to ascertain whether it contained PFAS. But, according to USAF checks on 11 fire suppression systems in 2016, foam contained levels of PFOA reaching 99 million ppt and PFOS of up to 9.5 billion ppt.[51] Given such high readings, even miniscule releases have the potential of contaminating soil and water.

Figure 6: An accident released hundreds of liters of PFOS-contaminated firefighting foam at a building on Kadena Air Base on 30 September 2014. (USAF via FOIA)

Figure 7: On Kadena Air Base in December 2013, an accident blamed on a malfunction discharged tens of thousands of liters of firefighting foam from a hangar. (USAF via FOIA)

At MCAS Futenma, between 2005 and 2009, there were at least three spills involving a total of 2,700 liters of AFFF. One incident, in August 2007, leaked off the base "into a short creek, then immediately into a cave." According to interviews with current and former Marines, the actual number of accidents is much higher, some incidents have not been cataloged and, when a spill occurs, the volume of foam released is underreported.[52]

MCAS Futenma's negligent operating procedures with AFFF are detailed in an internal investigation into an accident which occurred in December 2019. Marines and civilian technicians were conducting maintenance on a USMC AH-1Z helicopter inside a hangar when they decided to use an auxiliary power unit – a machine normally used outdoors – without authorization from their supervisors. The hot gases from the machine set off the building's sprinkler system, filling the hangar with AFFF. The report catalogs the ensuing confusion as Marines unsuccessfully scrambled to switch off the system: they did not have radios to notify emergency responders; the cut-off switch for the sprinklers was inside a locked room for which the Marines did not have a key; and, for 30 minutes, responders were unable to find the foam's Safety Data Sheet. By the time the Marines were able to shut down the sprinklers – 15 minutes after they'd been triggered – the system had sprayed approximately 38,000 liters of foam containing PFOA and PFOS. According to the investigation, the accident created 95,000 – 114,000 liters of waste water, most of which entered the hangar's underground storage tanks but, due to rain and high winds, the spill "was not fully contained" and "some of the AFFF blew away and or got washed into the storm drains."[53]

Figure 8: Photographs show the aftermath of a 5 December 2019 accident which released almost 40,000 liters of PFAS-contaminated firefighting foam at MCAS Futenma. (USMC via FOIA)

Following aircraft accidents, the AFFF deployed by emergency crews can also impact the environment. In October, 2017, for example, a USMC CH-35 crashed in a field in Higashi Village, northern Okinawa; according to the accident report, USMC fire crews used AFFF to extinguish the blaze and "the remnants of AFFF was visible in the immediate vicinity of the aircraft." Following the crash, the USMC cordoned off the site and, in the following days, removed the soil before Japanese authorities could sample it. After the USMC departed, Japanese investigators conducted checks in the vicinity, detecting contamination from benzene (an ingredient in fuel) and radioactive strontium-90, likely from the helicopter's in-blade inspection systems; investigators did not check for PFAS contamination.[54]

3. AFFF Disposal

FOIA-obtained documents indicate that a third way in which military PFAS has been contaminating Okinawa is through disposal. Between 2014 and 2015, at least 142 tons of AFFF concentrate, originating from MCAS Futenma, were disposed under military contract with a civilian firm; the company first incinerated the chemicals and then buried the waste at a landfill site in Okinawa City. According to the disposal manifests, the USMC had informed the contractor the substances were "waste alkali" and did not notify them of the presence of PFAS. When the incident was reported in the media by the author in 2019, the USMC defended its procedures as "appropriate," maintaining its description of the foam as "waste alkali" was standard and it "maintains dialogue with all of its contractors."[55]

In 2017 – two years prior to the revelations becoming public – Okinawa Prefecture revoked the contractor's permit to dispose of industrial waste due to illegal disposal operations. Subsequent surveys of the landfill site detected contamination in the groundwater as high as 2600 ppt for PFOA and 1120 ppt for PFOS.

Mainland Japan

FOIA-released documents reveal US military bases in mainland Japan have experienced accidents involving AFFF which were not reported to Japanese authorities, furthermore the drinking water supplies at two installations are now known to be PFAS-contaminated.

Documents from MCAS Iwakuni, Yamaguchi Prefecture, suggest the USMC in Japan has been aware of the risks of AFFF for more than two decades. According to an accident report from August 1997, a mechanic emptied 3000 liters of foam and water from a fire truck into the base's drains, an action that environmental officers warned was "harmful to the water." Another spill of AFFF in February 2013 describes it as a "hazardous substance," then in May 2015, a spill of "PFOS contaminated" foam leaked off the base but the USMC did not inform Japanese authorities. Between 1997 and 2016, there were at least 12 spills of firefighting foams at MCAS Iwakuni.[56]

At Misawa Air Base, Aomori Prefecture, FOIA-obtained reports catalog four large releases of firefighting foams between 2012 and 2017. One incident in July 2012 spilled AFFF outside the base into the water network which irrigates rice fields; photographs from the scene show large volumes of bubbles outside the facility. One farmer complained about the leak to local authorities, prompting them to investigate; according to the USAF follow-up report, "AFFF release to environment is not harmful to humans and agriculture."[57]

The drinking water supply at Misawa Air Base has been contaminated with PFAS. According to USAF checks, the water on the base – sourced from five wells and the nearby lake – was contaminated with PFOA/PFOS at 13 ~ 25 ppt in 2017; and 17 ~ 19 ppt in 2018. Water at nearby Draughon Range – also supplied by groundwater wells – contained levels of 5 ~ 41 ppt in 2017 and 38 ~ 48 ppt the following year.[58]

Figure 9: AFFF spilled from Misawa Air Base into local rice fields in 2012 (USAF via FOIA).

Outside Okinawa, the most severe *known* case of military PFAS contamination has occurred at Yokota Air Base, Tokyo, headquarters of the US military in Japan. Among the accidents involving AFFF was one in 2012 whereby 3000 liters of concentrate seeped into the ground from a storage tank. The report noted the concentrate contained PFOS - described as an "emerging environmental contaminant" – but Japanese authorities were not alerted.[59]

Yokota Air Base's drinking water – supplied to

approximately 11,500 service members, dependents and civilian employees – is drawn from eleven wells within the installation. According to USAF reports from 2016, this water was contaminated with PFOA/PFOS levels of 35 ppt.[60] Research led in 2005 by Koizumi linked the installation to PFOS contamination of the Tama River of 440 ppt, the highest concentration detected in the river.[61]

In response to this author's research into contamination at Yokota Air Base, in 2018, Tokyo City officials checked wells near the facility; one well in Tachikawa, contained PFOA/PFOS at 1,340 ppt while another at Musashi Murayama had 143 ppt. The US military did not respond to the city's requests to inspect the base so officials were unable to confirm the source of the pollution.[62]

Meanwhile, Naval Air Facility Atsugi, Kanagawa Prefecture, experienced at least four leaks of AFFF between 2009 and 2016 but the accident reports do not cite the volumes released or the exact product involved. Data announced by the Japanese government in 2020 showed one river near the base was contaminated with PFOA/PFOS levels of 249 ppt.[63]

In Japan, the problems surrounding AFFF usage and disposal are not limited to US military bases. In February 2020, the Japanese government admitted that its own Self-Defense Forces possessed AFFF stocks totaling approximately 400,000 liters; it announced it was planning to replace them with new formulae which, although not containing PFOS would contain other PFAS.[64]

MCAS Futenma, April, 2020: Ongoing Problems, Small Signs of Progress

On the evening of April 10, 2020, Ginowan City officials received a phone call from a children's daycare center near MCAS Futenma informing them that foam was spilling off the base. Next, the city was contacted by the Okinawa Defense Bureau who told them there had been a leak.[65] When Ginowan City workers arrived outside the base's perimeter fence, they saw large volumes of foam pouring from the installation's storm drains.

That evening, the USMC released its first statement:

> On 10 April, 2020 at approximately 4:45pm, local time, a fire suppression system inside a hangar aboard Marine Corps Air Station Futenma activated and discharged Aqueous Film Forming Foam (AFFF). Some AFFF has been contained, and an assessment is being conducted to determine how much went off of the installation. MCIPAC environmental personnel are in contact with GOJ, Prefectural, and municipal authorities. As this incident is under investigation, we are currently unable to comment on specifics. Individuals who may encounter the foam should remain clear of it.[66]

Later, the USMC estimated that the leak had involved 232,000 liters of AFFF and water; 148,000 liters had left the base.[67]

The day after the accident, local firefighters waded into the waterways outside MCAS Futenma and tried to scoop the foam into buckets – but the volumes proved too large. Although Marines cleaned up the spill within the base, they offered no assistance outside.[68] When Colonel David Steele, MCAS Futenma commanding officer, left the base to inspect the city's clean-up attempts, he assured local officials that the foam would subside if it rained.[69] Airborne clumps of AFFF floated through civilian communities, coating children's play equipment and the walls of homes; the city office dispatched patrol cars to

drive through the streets warning residents to stay away from the drifting foam.

In the following days, the AFFF spread via waterways to the sea two kilometers away. Tests revealed combined PFOA/PFOS levels in the Uchidomari River of 255 ppt and 36 ppt in the sea; other PFAS, including PFHxS and PFHxA, were also detected.[70]

Immediately after the accident, Okinawan officials demanded access to MCAS Futenma under the agreement on Cooperation Concerning Environmental Matters. On April 16, the USMC permitted Japanese central government representatives to enter MCAS Futenma but these officials did not invite Okinawan Prefecture or Ginowan City staff to accompany them.[71] Following an apology from the Japanese Minister of Defense, Kono Taro, Okinawan officials were granted access to MCAS Futenma to visit the site of the spill on April 17.[72] They requested soil samples from the scene for independent testing but on April 24, the USMC removed soil from the site without handing any over to Okinawan officials.[73] On May 11, after repeated demands, the USMC shared soil samples with the Prefecture.[74]

The USMC stated it would investigate the cause of the leak.

Conclusion

In recent years, the DoD has announced the results of PFOA and PFOS surveys of military installations within the United States, enabling the public to understand the extent of contamination – but in Japan, military opacity, longstanding bilateral agreements and the Japanese government's reluctance to set drinking water limits have thwarted such awareness. Requests under FOIA have succeeded in disclosing how accidents and lax safety protocols have allowed AFFF to enter the environment at Japanese facilities. But as noted above, the reports released to date likely only reveal a small proportion of the problem, so further research should be conducted to obtain historic and current information on AFFF usage, disposal and the health consequences for military and civilian populations.

Especially urgent is the contamination at Kadena Air Base, the source of drinking water for 450,000 residents of Okinawa Prefecture. Immediate checks need to be conducted at the site of the former fire training area near the Dakujaku River to determine whether the aquifer beneath the base has been and remains contaminated. If confirmed, remediating the problem will be a complex undertaking, necessitating treatment of the Kadena Well Field and the Dakujaku River; failure might force the Prefecture to seek alternative sources for residents' drinking water, a challenge unparalleled in the island's recent history.

On Okinawa, little is known about how long this contamination has been occurring; surveys of blood banks suggest exposure dates at least from the early-1980s and current elevated levels in the blood of Ginowan residents confirm ongoing exposure. No wider surveys to ascertain PFAS levels in a wider cohort have been conducted, nor have there been any investigations into health problems. Epidemiological studies are imperative for residents, former and active service members (particularly firefighters), dependents and base workers. The data ought to be shared with all stakeholders – including the DoD, local communities and national governments – to ensure that the health of all those exposed receives priority over bilateral prioritization of public image.

Currently, the US and Japanese governments' efforts to limit PFAS usage, disposal and contamination are focused on just two of the

substances – PFOA and PFOS – but, given the large number of different PFAS contained in AFFF, it is important for Washington and Tokyo to approach PFAS as a class of chemicals, factoring this into implementing on and off-base checks, assure drinking water and environmental standards, fully monitor the JEGS list of hazardous substances, and address environmental dangers. This approach would encourage the US and Japanese militaries to reconsider their decision to replace AFFF with foams which contain other PFAS; civilian airports worldwide have made the transition to PFAS-free foam with no reduction in safety.[75] The US and Japanese militaries should do likewise.

Fundamentally, there needs to be an overhaul of SOFA, the Japan-US Joint Committee, and the opaque agreements governing military environmental infractions and policies prioritizing military secrecy over the welfare of citizens and soldiers in Japan. Okinawa should be prioritized in light of the concentration of US military bases and soldiers stationed there and the large civilian population on the base perimeters. Such reforms need to hold the military to account for remediating past and present contamination, allow on-site checks by Japanese authorities, and include legal penalties for commanders who allow their bases to harm the communities they ought to protect. Without such policies, the US military, which has been polluting Japan for more than seven decades with impunity, will continue to do so in the years to come, undermining both public health and international relations between Japan and the United States.

Jon Mitchell is co-author of *Eien no kagakubusshitsu – Mizu no PFAS osen* (https://www.iwanami.co.jp/book/b521323.html) ("Forever Chemicals" – How PFAS have contaminated Japan and the Globe) released by Iwanami Shoten, August 2020. The first Japanese book to explore PFAS contamination, it describes the damage caused by military and industrial facilities to the environment and human health. The two co-authors are Koizumi Akio, Emeritus Professor Kyoto University, who has been investigating factory pollution for more than two decades, and Shimabukuro Natsuko, TV director of Ryukyu Asahi Housou, whose award-winning documentaries explore military contamination in Okinawa Prefecture.

Mitchell's English-language book, *Poisoning the Pacific* (https://rowman.com/ISBN/9781538130339/Poisoning-the-Pacific-The-US-Military's-Secret-Dumping-of-Plutonium-Chemical-Weapons-and-Agent-Orange), will be published by Rowman & Littlefield in October 2020. Described by Noam Chomsky as "an eloquent call to bring this tragedy to an end," it catalogs the environmental damage caused by military operations on Okinawa, mainland Japan, the Marshall Islands and the US territories of Guam, the Commonwealth of the Northern Mariana Islands and Johnston Atoll.

Eien no kagakubusshitsu – Mizu no PFAS Osen ("Forever Chemicals" – How PFAS have contaminated Japan and the Globe) Iwanami Shoten, 2020

Notes

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[53] According to the report, the cost of shipping the waste to mainland Japan for disposal was estimated at $500,000. One expert concluded the accident was “completely preventable”; the report’s authors surmised “multiple personnel did not know how fire detection system worked.” “Command Investigation into the Incident Involving the Discharge of Aqueous Film Forming Foam inside a Hanger (sic) Building,” USMC 1st Marine Aircraft Wing, February 12, 2020.
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