throat, vomiting and similar results as inhalation. Sores develop on skin with contact to large amounts of chloroform. The US DHHS declares chloroform to be a probable carcinogen. The MCL is not determined for this chemical, but the ACGIH TLV is set at 10 ppm. The NIOSH REL is set at 2 ppm or 9.78 mg/m^3.

Chloromethane

Chloromethane is also known as methyl chloride. Symptoms often seen include: convulsions, nausea or vomiting, dizziness, drowsiness, incoordination, confusion, abdominal pains, hiccoughs, diplopia, delirium, convulsions, irritation to the eye, coma, and even death. High levels of exposure greatly affect the nervous system, liver, kidneys, and heart. No evidence exists to imply that chloromethane is a carcinogen. However, the EPA has determined that it is a probable carcinogen. The ACGIH TLV is set at 50 ppm. The NIOSH REL is set at 100 ppm.

Dibromochloromethane

Dibromochloromethane is also known as chlorodibromomethane. Symptoms often seen include: irritation and narcotic effects. No cases of cancer are seen in humans exposed to this chemical. The MCL for this chemical is set at 0.10 ppm.

Dichlorodifluoromethane

Dichlorodifluoromethane exposure symptoms often seen include: dizziness, tremor, asphyxia, unconsciousness, cardia arrhythmias, cardiac arrest, conjunctiva irritation, fibrosing alveolitis, liver changes, and narcotic effects. The ACGIH TLV and NIOSH REL are set at 1000 ppm.

Freon-113

Freon-113, also known as 1,1,2-Trichloro-1,2,2-trifluoroethane, is a mildly toxic chemical. Symptoms often seen include: irritation to skin and throat, drowsiness, dermatitis, and central nervous system depression. The NIOSH REL is set at 1000 ppm.

Methylene Chloride

Methylene Chloride, also known as dichloromethane, is not found naturally in the environment. This chemical is a colorless liquid with a mild, sweet odor used as an industrial solvent and paint stripper. Inhalation of low-levels results in a person becoming less attentive and less accurate. Effects of inhalation at high-levels have a narcotic

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effect. Symptoms often seen include: dizziness, nausea, mental confusion, fatigue, vomiting, headaches, and a tingling sensation in the fingers and toes. Contact with this chemical by skin results in irritation, redness, pain, and even burning. The WHO declares methylene chloride as carcinogenic to humans. The US DHHS and the EPA have determined that this chemical is a probable carcinogen. The MCL has not been determined for this chemical, but the ACGIH TLV has been set at 50 ppm.

Octachlorodibenzo-p-dioxin (OCDD)
Octachlorodibenzo-p-dioxin (OCDD) is an experimental teratogen and an irritant to the eye. Ingestion of this chemical results in poisoning. These solvents are fat-soluble and therefore accumulate in the tissues of animals and humans in the food chain. Humans are typically exposed to these chemicals through the consumption of fish, meat, and milk. Exposure to dioxins results in a drop in sperm count, an increase in testicular and prostate cancer, endometriosis, and an increased risk of developing breast cancer. The MCL and ACGIH TLV have not been determined for this chemical.

Pentachlorinated dibenzofurans
Pentachlorinated dibenzofurans is a chemical with great health effects to the human body. A significant reduction of thymus weight and suppression of the activity of cytotoxic T lymphocytes, in addition to a suppression on both cell-mediated and humoral immunity. The MCL and ACGIH TLV have not been determined for this chemical.

Perchloroethylene (PCE)
PCE, also known as perchloroethylene or tetrachloroethylene, is a moderately toxic chemical. Inhalation results in conjunctiva irritation, general anesthesia, hallucinations, distorted perceptions, local anesthesia, coma, and pulmonary changes. Symptoms of exposure may include irritation to eyes, skin, nose, throat, and respiratory system, as well as nausea, dizziness, incoordination, headache, drowsiness, skin erythema, and liver damage. Ingestion results in irritation to the gastrointestinal tract. This chemical is a potential carcinogen. The MCL has not been determined for this chemical, but the ACGIH TLV is set at 50 ppm. The NIOSH REL recommends that workplace exposure is minimized.

Titanium tetrachloride

Titanium tetrachloride is a colorless to pale yellow liquid that has fumes with a strong odor. If it comes in contact wit water, it rapidly forms hydrochloric acid, as well as titanium compounds. It is not found naturally in the environment and is made from minerals that contain titanium. It is used to make titanium metal and other titanium-containing compounds, such as titanium dioxide, which is used as a white pigment in paints and other products.

Titanium tetrachloride is very irritating to the eyes, skin, mucous membranes, and the lungs. Breathing in large amounts can injure the lungs seriously enough to cause death. There is no evidence that chronic exposure to titanium tetrachloride causes cancer in humans. The MCL and ACGIH TLV haven't been determined for this chemical. The NIOSH REL is set at 0.001 mg/m^3.

1,2,4-Trichlorobenzene

1,2,4-Trichlorobenzene is an experimental teratogen. This chemical is an irritant to the eyes, skin, and mucous membrane. Symptoms often affect the liver, kidney, and adrenal gland. The carcinogenicity of this chemical is unknown. The MCL is set at 0.07 mg/L. The ACGIH TLV is set at 5 ppm.

1,1,1-trichloroethane

1,1,1-trichloroethane is synthetic material that is also known as methyl chloroform. Symptoms often seen include: dizziness, conjunctiva irritation, hallucinations or distorted perceptions, motor activity changes, irritability, aggression, hypermotility, diarrhea, poor equilibrium, dermatitis, nausea or vomiting, cardiac arrhythmias, and other gastrointestinal changes. The IARC has determined the carcinogenicity of this chemical is not classifiable. The ACGIH TLV and NIOSH REL are set at 350 ppm.

Trichloroethylene (TCE)

TCE is also known as trichloroethylene. Symptoms of inhalation and ingestion are mildly toxic to humans and include: eye irritation, somnolence, hallucinations or distorted perceptions, gastrointestinal changes, and jaundice. Addiction results in those that work with the chemical. High-levels of exposure lead to headache and drowsiness, and eventual ventricular fibrillation resulting in cardiac failure, which in turn damages the liver and other organs. NIOSH has determined this chemical to be a potential occupational carcinogen; the recom-

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mended REL is 2 ppm. The MCL is set at 0.005 mg/L and the ACGIH TLV is set at 50 ppm.

Tetrahydrofuran
Tetrahydrofuran, also known as tetramethylene oxide or THF, is a mildly toxic chemical. Symptoms often seen include: general anesthesia, irritant to eyes, mucous membranes, and upper respiratory system, narcotic in high concentrations, liver and kidney damage, and central nervous system depression. The NIOSH REL is set at 200 ppm.

Vinyl Chloride
Vinyl Chloride is moderately toxic by ingestion and a severe irritant to skin, eyes, and mucous membranes. High concentrations of vinyl chloride act as an anesthetic and chronic exposure can lead to liver injury. The carcinogenicity of vinyl chloride is confirmed in producing a rare cancer in the liver and blood tumors. The production of vinyl chloride is also a source of dioxins.[3] The MCL is set at 0.002 mg/L and the ACGIH TLV is set at 5 ppm.

High Explosives Compounds

Explosives are chemical compounds or mixtures that are typically used in detonators in bombs. Large amounts of gas and heat are generated with the production of sudden pressure effects. As a result, the explosives vary in intensity and resistance. Mixing of chemicals produces varied effects and intensities upon explosion.

1,3-Dinitrobenzene
1,3-dinitrobenzene, also known as 2,4-dinitrobenzene, is a synthetic explosive formed as a by-product from the manufacturing of TNT. Mixing this chemical with tetranitromethane results in a high explosive that is very sensitive to sparks. No odor or taste is associated with this chemical. This chemical is slightly soluble in water and does not stick strongly to soil and as a result travels through the soil into the groundwater. Symptoms of exposure include headache, anoxia, cyanosis, visual disturbance, central scotomas, bad taste, burning mouth, dry throat, thirst, anemia, liver damage, nausea, and dizziness. Long-term exposure results in a reduction of the number of red blood cells. The carcinogenicity of this chemical is undetermined for humans. The NIOSH REL is set at 1 mg/m^3.

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Dinitrotoluene (DNT)

Dinitrotoluene (DNT) is a poison that is carcinogenic with experimental tumorigenic and teratogenic data. Symptoms of exposure may include anozia, cyanosis, anemia, jaundice, and reproductive effects. The MCL has not been determined for this chemical but the ACGIH TLV is set at 1.5 mg/m³. The NIOSH REL is set at 1.5 mg/m³.

2,6-Dinitrotoluene

2,6-Dinitrotoluene is a synthetic explosive that is one of the six forms of chemicals of dinitrotoluene. This chemical is a pale yellow solid with a slight odor. Health effects from exposure to this chemical are uncertain. The nervous system and blood of exposed workers may be affected. The IARC has determined that this chemical is a potential carcinogen.

HMX

HMX, also known as cyclotetramethylene tetranitrate, is an acronym for High Melting Explosive. Other names for this chemical include: octogen and cyclotetramethylene-tetranitramine. It is a colorless solid that dissolves slightly in water with an unknown taste and smell. This chemical is made from other chemicals known as hexamine, ammonium nitrate, nitric acid, and acetic acid. The high volatility of this chemical enabled its use in explosives, rocket fuels, and burster chargers. No information is known on how you might be exposed to HMX in the environment and the information on adverse health effects is limited. The EPA has concluded that the carcinogenicity to humans is not classifiable. The MCL and ACGIH TLV have not been determined for this chemical.

4-Nitrotoluene

4-Nitrotoluene is a poison that is moderately toxic by ingestion. Contact with skin is mildly toxic. This chemical is combustible upon exposure to heat or flame. Symptoms of exposure may include anoxia, cyanosis, headache, weakness and exhaustion, dizziness, ataxia, difficulty breathing, tachycardia, nausea, and vomiting. When it is combined with tetranitromethane a very sensitive high explosive is created. The NIOSH REL is set at 11 mg/m³.

4-PETN (Pentaerythritol Tetranitrate)

PETN, also known as Pentaerythritol Tetranitrate, is a hazardous chemical that explodes when shocked or exposed to heat. Ingestion

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results in dermatitis. Other symptoms of exposure include: headaches, weakness, and fall in blood pressure. The MCL and ACGIH TLV have not been determined for this chemical.

4-Perchlorate
Perchlorate is synthetic and man-made. Perchlorates are incredibly unstable materials. Irritation to the body results in contact with any perchlorate. Mixtures of this chemical form explosives. This chemical affects the functioning of the thyroid gland. Alteration to thyroid gland functions can potentially lead to the formation of tumors.

4-RDX
RDX, otherwise known as Royal Demolition Explosive, is one of the most powerful high explosives in use today. Other names for this chemical include: cyclotrimethylene-trinitramine;cyclonite, cyclonite, and 1,3,5-trinitro-1,3,5-triazine. As a synthetic, white powder, when RDX is burned fumes are created. This chemical is rarely used alone and is typically combined with other explosives, oils, or waxes. Symptoms of exposure to RDX include: seizures, nausea, headache, irritability, weakness and exhaustion, tremor, dizziness, insomnia, and vomiting. Knowledge of birth defects or affects on reproduction in humans is yet to be discovered. The carcinogenic properties of RDX are unknown. The MCL has not been determined for this chemical, but the ACGIH TLV is set at 1.5 mg/m^3. The NIOSH REL is set at 1.5 mg/m^3.

Tetryl
Tetryl is also known as nitramine and 2,4,6-trinitrophenyl-n-methylnitramine. This explosive is an extremely sensitive high explosive, more so than TNT to shock and friction. When combined on contact with trioxygen difluoride the chemical explodes on contact. This chemical is an irritant, sensitizer, and allergen. Symptoms of exposure may include sensitization dermatitis, redness, inflammation of the cornea, sneeing, anemia, cough, coryza, irritability, malaise, headache, weakness and exhaustion, insomnia, nausea, vomiting, and liver and kidney damage. The NIOSH REL is set at 1.5 mg/m^3.

2,4,6-Trinitrotoluene
2,4,6-Trinitrotoluene is an explosive commonly referred to as TNT. Ingestion results in hallucinations or distorted perceptions, cyanosis, and gastrointestinal changes. Contact with this chemical results in

skin irritation. Health effects include jaundice, cyanosis, sneezing, cough, sore throat, peripheral neuropathy, muscle pain, kidney damage, cataract, sensitization dermatitis, headaches, weakness, anemia, and liver injury. The MCL has not been determined for this chemical, but the ACGIH TLV is set at 0.5 mg/m^3. The NIOSH REL is set at 0.5 mg/m^3.

Fuel Components and other Organic Chemicals

Toxic chemicals are known to disrupt normal bodily functions, including the functions of hormones. Hormones provide a number of services as natural chemicals to the human body including: act as messengers, travel through the blood stream, regulate various bodily processes, and coordinate the body's activities to maintain health through controlling growth, development, and behavior.[2]

Acenapthylene

Acenapthylene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters in all tissues that contain fat. Acenapthylene is stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The US DHHS has determined that acenapthylene is a known animal carcinogen; however, the EPA has determined that the human carcinogenicity is not classifiable. The MCL and ACGIH TLV have not been determined for this chemical.

Acetone

Acetone is a colorless liquid with a distinct smell and taste that is naturally found in the environment as well as manufactured. Other names for this chemical include: dimethylketone, 2-propanone, and beta-ketopropane. In small amounts, the liver breaks acetone down into energy making chemicals used for normal body functions. Exposure results in entry of acetone into the blood stream and is subsequently carried to the rest of the organs. Inhalation of moderate-to-high amounts for even short periods of time can result in nose, throat, lung, and eye irritation, headaches, light-headedness, confusion, increased pulse rate, effects on blood, nausea, vomiting, unconsciousness and possibly coma, and the shortening of the menstrual cycle in women. Ingestion of small amounts typically does not cause harm. However, ingestion of high levels results in abdominal pain, nausea,

and vomiting. Effects of long-term exposure to acetone include kidney, liver, and nerve damage, increased birth defects, metabolic changes, and coma. The use of alcoholic beverages enhances the toxic effects of acetone. The US DHHS, the IARC, and the EPA have not classified acetone for carcinogenicity in humans. The MCL has not been determined for this chemical. The ACGIH TLV is set at 750 ppm. The NIOSH REL is set at 0.1 ppm.

Ammonia
Ammonia exposure symptoms often seen include: irritation to eyes and mucous membranes. Symptoms often seen include: breathing difficulty, wheezing, chest pain, pulmonary edema, skin burns, liquid, and frostbite. High-levels of exposure result in blindness, lung damage, heart attack, or death. The US DHHS, IARC, and the EPA have not classified the carcinogenicity of ammonia. The ACGIH TLV and NIOSH REL are set at 25 ppm.

Anthracene
Anthracene is a skin irritant and allergen. The carcinogenicity of this chemical is probable.

9,10-Anthracenedione
9,10-Anthracenedione, also known as anthraquinone, is a mild allergen.

Asbestos
Asbestos is comprised of six different minerals that are found in nature. This chemical enters the drinking water from natural sources in addition to corroded asbestos worn away from cement pipes. The separable, heat resistant fibers that make up the minerals are strong and flexible enough to be spun and woven. As a result, asbestos was widely used in building materials, friction products, heat resistant fabrics, packaging, gaskets, and coatings. Inhalation of lower levels of asbestos may result in changes called plaques in the linings. Long-term inhalation of asbestos fibers may result in scar-like tissue in the lungs and in the lining that surrounds the lung. Breathing difficulties, restricted pulmonary function, and heart enlargements arise as a result of exposure, eventually leading to disability and death. The US DHHS, the WHO, and the EPA have determined that asbestos is a human carcinogen and produces lung tumors. The MCL is set at 7 million fibers/L and the ACGIH TLV is set at 2 fibers/cubic centimeters.

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Benzaldehyde
Benzaldehyde is an allergen. Symptoms often seen include: dermatitis, central nervous system depression, and anesthetic. The carcinogenicity of this chemical is probable.

Benzene
Benzene is a colorless liquid with a sweet odor that is formed from natural processes as well as human activities. With its wide distribution throughout the US, the uses of benzene are expansive, some of which include rubbers, lubricants, dyes, degreasers, detergents, drugs, pesticides, and as a major component of gasoline. This chemical enters the drinking water through leaking underground gasoline and petroleum tanks or improper waste disposal. Inhalation of high levels of benzene can result in drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, unconsciousness, and even death. Diseases that result from inhalation include Hodgkin's Disease and lymphomas. Ingestion of benzene is moderately toxic and is a severe eye and moderate skin irritant. Long-term exposure results in harmful effects on the bone marrow, leading to myeloid leukemia, as well as a decrease in red blood cells that leads to anemia. In addition excessive bleeding can occur and the immune system can be affected. Long-term exposure of workers to this chemical is linked to brain cancer and leukemia. Additionally, other possible health complications may arise in reproductive and developmental effects. The US DHHS has determined that benzene is a known human carcinogen. The MCL is set at 0.005 mg/L and the ACGIH TLV is set at 10 ppm. The NIOSH REL is set at 0.1 ppm.

n-Butanol
n-Butanol is also known as n-butyl alcohol. Symptoms often seen include: conjunctiva irritation, unspecified respiratory system and nasal effects, severe skin and eye irritant, corneal inflammation, slight headache and dizziness, slight irritation of the nose and throat, and dermatitis. The ACGIH TLV and NIOSH REL are set at 50 ppm.

Delta-BHC
Delta-BHC is also known as delta-benzenehexachloride and is a moderately toxic chemical.

Gamma BHC
Gamma BHC is also known as the gamma isomer of benzene hexachloride. Symptoms often seen include: irritation to the eyes skin, nose, and throat, headache, nausea, respiratory difficulty, convulsions, dyspnea, and cyanosis. This chemical is a known carcinogen. The ACGIH TLV and NIOSH REL are set at 0.5 mg/m^3.

Benzo(a)anthracene
Benzo(a)anthracene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. This chemical is a poison by intravenous routes that is commonly an air contaminant of food, water, and smoke. The IARC and the EPA have determined it is a probable human carcinogen. The MCL and ACGIH TLV levels have not been determined.

Benzo(a)pyrene
Benzo(a)pyrene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. This chemical is a poison via subcutaneous, intraperitoneal, and intrarenal routes that is commonly an air contaminant of food, water, and smoke. Experimental teratogenic and reproductive effects have been found. The IARC and the EPA have determined it is a probable human carcinogen. The MCL is set at 0.0002 mg/L and the ACGIH TLV has not been determined for this chemical.

Benzo(b)fluoranthene
Benzo(b)fluoranthene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The IARC and the EPA have determined this chemical to be a possible human carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

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Benzo(k)fluoranthene
Benzo(k)fluoranthene is a known carcinogen.

Benzo(g,h,i)perylene
Benzo(g,h,i)perylene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The IARC and the EPA have determined this chemical not classifiable as to the carcinogenicity to humans. The MCL and ACGIH TLV have not been determined for this chemical.

Benzoic Acid
Benzoic Acid is found naturally in resins and manufactured synthetically. It is a colorless crystalline solid and is used as a food preservative and in pharmaceuticals and cosmetics. Inhalation affects the human nervous system, dypsnea, and allergic dermatitis. This chemical is a poison by subcutaneous route and is moderately toxic by ingestion and intraperitoneal routes. In addition, it is a severe eye and skin irritant. The MCL and ACGIH TLV have not been determined for this chemical.

Bis-(2-ethylhexyl)phthalate
Bis-(2-ethylhexyl)phthalate, also known as di-sec-octyl phthalate, is a poison upon entry into the blood stream. Ingestion affects the gastrointestinal tract. In addition, this chemical is a mild skin and eye irritant and can cause liver damage. This chemical is a confirmed carcinogen with experimental carcinogenic and tumorigenic data. The MCL is set at 0.006 mg/L and the ACGIH TLV is set at 5 mg/m^3. The NIOSH REL is set at 5 mg/m^3.

Carbazole
Carbazole is a pesticide poisonous by intraperitoneal routes. Ingestion is moderately toxic. It is a questionable carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Carbon disulfide
Carbon disulfide is found naturally as well as a commercially made chemical. Symptoms often seen include: narcotic and anesthetic ef-

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fects to the central nervous system, dizziness, headache, poor sleep, anorexia, weight loss, Parkinson-like syndrome, coronary heart disease, gastritis, kidney, liver injury, eye and skin burns, respiratory failure, and even death. The US DHHS, the IARC, and the EPA have not determined the carcinogenicity of this chemical. The ACGIH TLV is set at 10 ppm. The NIOSH REL is set at 1 ppm.

Chrysene
Chrysene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The IARC has determined the carcinogenicity is not classifiable for humans. The EPA has determined that this chemical is a probable human carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Cyclohexane
Cyclohexane is also known as benzene hexahydride and hexahydrobenzene. Symptoms often seen include: irritation to eyes, skin, and respiratory system, drowsiness, dermatitis, narcosis, and coma. The ACGIH TLV and NIOSH REL is set at 300 ppm.

Cyclohexanone
Cyclohexanone is a severe eye irritant. Symptoms often seen include: changes in the sense of smell, headache, narcosis, coma, dermatitis, conjunctiva irritation, and unspecified respiratory system changes, mild narcotic, and a skin and eye irritant. The ACGIH TLV and NIOSH REL are set at 25 ppm.

Dibenz(a,h)anthracene
Dibenz(a,h)anthracene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The US DHHS has determined that this chemical is a known animal carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Di-n-octylphthalate

Di-n-octylphthalate is also known as di-sec-octylphthalate. This chemical affects the gastrointestinal tract, central nervous system, liver, reproductive system, and gastrointestinal tract. This chemical is also a mild skin and eye irritant. This chemical is a known carcinogen. The ACGIH TLV and NIOSH REL are set at 5 mg/m^3.

1,2-Diphenylhydrazine

1,2-Diphenylhydrazine, also known as Hydrazobenzene, is a white solid with no information on smell or flammability. This manufactured chemical does not dissolve easily in water and when placed in water it rapidly breaks down into other toxic chemicals. This chemical is currently used in medicines to treat inflammation and a type of arthritis. Effects of ingestion lead to chemical poisoning. Diphenylhydrazine is a confirmed carcinogen with experimental carcinogenic and tumorigenic data. Poison by ingestion. The MCL and ACGIH TLV have not been determined for this chemical.

Ethyl Acetate

Ethyl Acetate is a chemical that can cause dermatitis. Inhalation results in severe irritation to mucous membranes and upper respiratory tract, poisoning, human systemic effects such as olfactory changes, conjunctiva irritation, and pulmonary changes. Ingestion of this chemical is mildly toxic in causing irritation to the gastrointestinal tract with symptoms such as nausea, vomiting, and diarrhea. Long-term exposure yields conjunctival irritation and corneal clouding, congestion of the liver and kidneys. High concentrations have a narcotic effect in addition to resultant liver and kidney damage. Chronic poisoning may lead to anemia with leukocytosis (a transient increase in the white blood cell count), cloudy swelling, and fatty degeneration of the viscera. The MCL has not been determined for this chemical and the ACGIH TLV is set at 400 ppm. The NIOSH REL is set at 400 ppm.

Ethylbenzene

Ethylbenzene is a moderately toxic chemical. Symptoms often seen include: eye, sleep, and pulmonary changes, eye and skin irritation, headache, dermatitis, narcosis, coma, dizziness, irritation of the nose and throat, and a sense of constriction in the chest. The ACGIH TLV and NIOSH REL are set at 100 ppm.

Fluoranthene
Fluoranthene is a moderately toxic chemical. The carcinogenicity is probable.

n-Hexane
n-Hexane is a slightly toxic chemical made from crude oil. Symptoms often seen include: irritation to the eyes, skin, respiratory system, central nervous system, and peripheral nervous system, paralysis, and hallucinations. The US DHHS, the IARC, and the EPA have not classified the carcinogenicity of this chemical. The ACGIH TLV and NIOSH REL are set at 50 ppm.

2-Hexanone
2-Hexanone is also known as Butyl methyl ketone or Methyl butyl ketone. This chemical is moderately toxic. Symptoms often seen include: irritation to the eyes and nose, peripheral neuropathy, weakness, exhaustion, paresthesia, vomiting, dermatitis, headache, and drowsiness. This chemical is a skin and eye irritant. The ACGIH TLV is set at 5 ppm. The NIOSH REL is set at 1 ppm.

Indeno(1,2,3-c,d)pyrene
Indeno(1,2,3-c,d)pyrene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The IARC has determined this chemical to be a possible human carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Methyl Ethyl Ketone (MEK)
Methyl Ethyl Ketone (MEK) is a strong irritant that affects the peripheral nervous system and central nervous systems. Effects of inhalation at low-levels of exposure result in human systemic effects, including conjunctiva irritation and effects on the nose and respiratory system. Inhalation at high levels results in headaches, dizziness, nausea, shortness of breath, and vomiting, in addition to central nervous system depression and unconsciousness. Effects of ingestion result in abdominal pain and nausea. Contact by skin results in redness, itching, and pains; long-term exposure results in dermatitis. The MCL has not been determined for this chemical, but the ACGIH TLV has been set at 200 ppm. The NIOSH REL is set at 200 ppm.

Methyl methacrylate
Methyl methacrylate is a moderately toxic chemical. Symptoms often seen include: sleep effects, excitement, anorexia, and blood pressure decrease. This chemical is a severe skin, eye, nose, and throat irritant. The ACGIH TLV and NIOSH REL are set at 100 ppm.

2-Methylnapthalene
2-Methylnapthalene is a white solid that is found naturally in fossil fuels. High-levels of exposure damages red blood cells. Symptoms of acute poisoning include: fatigue, lack of appetite, restlessness, and pale skin. Symptoms of a higher exposure include: nausea, vomiting, diarrhea, blood in the urine, and a yellow color to the skin. The US DHHS, the IARC, and the EPA have not classified the carcinogenicity of this chemical. The MCL and ACGIH TLV have not been determined for this chemical.

Nitrates
Nitrates ingested in large amounts can result in death. Symptoms often seen include: dizziness, abdominal cramps, vomiting, bloody diarrhea, weakness, convulsions, collapse, and even mental impairment. The carcinogenicity of this chemical is probable.

Nitrobenzene
Nitrobenzene is an industrial chemical typically used to manufacture aniline. Symptoms often seen include: general anesthetic, anoxia, dermatitis, anemia, respiratory stimulation, and vascular changes. This chemical is also an eye and skin irritant and is absorbed readily through the skin. The IARC has determined this chemical to be a probable carcinogen. The ACGIH TLV and NIOSH REL are set at 1 ppm.

N-nitrosodi-n-propylamine
N-nitrosodi-n-propylamine is a manufactured chemical for use in research and as a weed killer. The effect on humans remains unknown for this chemical. The US DHHS has determined that n-nitrosodi-n-propylamine is a probable carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Octadecanoic acid
Octadecanoic acid is also known as stearic acid. This chemical is a skin irritant. The carcinogenicity of this chemical is probable.

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Pentachlorophenol (PCP)
Pentachlorophenol (PCP) occurs as a colorless crystal. The smell varies with the temperature of this manufactured chemical. Uses of this chemical include use as a biocide and wood preservative. Symptoms of exposure may include sneezing, cough, weakness and exhaustion, anorexia, weight loss, sweating, headache, dizziness, nausea, vomiting, dyspnea, chest pain, high fever, and damage to the liver, kidneys, blood, lungs, nervous system, immune system, and gastrointestinal tract. Contact with skin and eyes cause dermatitis and irritation. The IARC has determined that this chemical is a possible carcinogen to humans. The MCL is set at 0.001 mg/L and the ACGIH TLV is set at 0.5 mg/m^3. The NIOSH REL is set at 0.5 mg/m^3.

Pheneanthrene
Pheneanthrene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The US DHHS has determined that pheneanthrene is a known animal carcinogen; however, the EPA has determined not classifiable to human carcinogenicity. The MCL and ACGIH TLV have not been determined for this chemical.

PCBs
PCBs are also known as polychlorinated biphenyls. Of the 109 PCBs, many affect hormones and are linked with brain cancer. This chemical is moderately toxic by ingestion and skin contact. The carcinogenicity of this chemical is probable. The MCL is set at 0.0005 mg/L, but the ACGIH TLV has not been determined for this chemical.

Pyrene
Pyrene is a poison through inhalation. This chemical is a skin irritant. The carcinogenicity of this chemical is probable.

Sulfates
Sulfates are elements combined with both sulfur and oxygen. These materials vary in toxicity.

Toluene

Toluene is a poison to humans via various routes. Inhalation, intravenous and subcutaneous routes prove to be mildly toxic. Effects of inhalation result in hallucinations, distorted perceptions, motor activity changes, antipsychotic, pyschophysiological test changes, and bone marrow changes. Other Symptoms of exposure may include irritation to nose and eyes, weakness and exhaustion, confusion, dizziness, headache, anxiety, muscle fatigue, insomnia, paresthesia, dermatitis, and liver and kidney damage. This chemical is an irritant to the eyes and skin and is linked to brain cancer. The MCL is set at 1 mg/L and the ACGIH TLV is set at 100 ppm. The NIOSH REL is set at 100 ppm.

1,3,5-Trinitrobenzene

1,3,5-Trinitrobenzene is a powerful explosive that has more power for shattering than TNT, but less sensitive to impact. This chemical is difficult to produce. Ingestion has proven moderately toxic. The MCL and ACGIH TLV have not been determined for this chemical.

Metals

Metals are found naturally in the environment and tend to remain for a long time, thereby increasing a greater likelihood for exposure. Some metals are useful in small amounts and even necessary for good health. Metals can accumulate in vegetables, grains, fruits, fish, and shellfish from surrounding soil and water. Health effects caused by heavy metals include reduced growth and development, cancer, and organ damage, which can lead to autoimmunity, rheumatoid arthritis, and diseases of the kidneys, circulatory system, and nervous system. Metals have a greater effect on children and exposure can result in learning difficulties, memory impairment, damage to the nervous system, and behavioral problems.[3]

Aluminum

Aluminum occurs naturally and makes up about 8% of the surface of the earth. It is always found combined with other elements such as oxygen, silicon and fluorine. This metal is silver-white and flexible. Uses primarily include cooking utensils, containers, appliances, build-

ing materials, paints, fireworks, glass, rubber, ceramics and consumers products such as antacids, astringents, buffered aspirins, food additives and antiperspirants. Low-level exposure to aluminum from food, air, water, or contact with skin is not thought to harm your health. Aluminum, however, is not a necessary substance for our bodies and too much may be harmful. People who are exposed to high levels of aluminum may have respiratory problems, bone diseases and skeletal problems, skin rashes and delays in neurological development. The Department of Health and Human Services, the International Agency for Research on Cancer, and the EPA have not classified aluminum for carcinogenicity. The SMLC is set at 0.05-0.2 mg/L. Both ACGIH and NIOSH have established guidelines values from 2 mg/m³ for soluble salts to 10 mg/m³ for aluminum for total dust.

Antimony

Antimony is a silvery-white, corrosive metal found naturally in the earth's crust. Typically, antimony is brought into the United States for processing, mixed with alloys for strength, and used in the flame retardant industry. Other uses of this chemical include: ceramics, glass, batteries, fireworks, and explosives. Antimony enters the drinking water through natural weathering of rock, industrial production, municipal waste disposal or manufacturing processes. Inhalation of high-levels will result in lung problems. Ingestion of high-levels of antimony will result in heart problems, stomach pain, diarrhea, vomiting, and stomach ulcers; other unknown effects may result from ingestion. Contact with this chemical results in irritation and burns. Medicinal uses of antimony exist in treating people infected with parasites. The US DHHS, the IARC, and the EPA have not classified antimony as to its human carcinogenicity. The MCL is set at 0.006 mg/L and the ACGIH TLV is set at 0.5 mg/m³. The NIOSH REL is set at 0.5 mg/m³.

Arsenic

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine and sulfur to form inorganic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds. It is mainly used to preserve wood. Its use in pesticides has been canceled or restricted.

It cannot be destroyed in the environment; it can only change its form. Organic arsenic compounds are less toxic than inorganic arsenic compounds.

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Arsenic was listed as the most dangerous substance in the Top 20 hazardous substances on the CERCLA priority List of Hazardous Substances for 2001.

Ingesting high levels of inorganic arsenic can result in death. Lower levels of arsenic can cause nausea and vomiting, decreased production of red and white cells, abnormal heart rhythm, damage to blood vessels, darkening of the skin, and a sensation of "pins and needles" in hand and feet. Arsenic is a human carcinogen and can notably increase the risk of cancer in the lung, skin, bladder, liver, kidney and prostate. The MLC is set at 0.05 mg/L, the ACGIH TLV at 0.5 mg/m^3, and the NIOSH REL at 0.002 mg/m^3. The WHO has established a provisional guideline value of 0.01 mg/L for arsenic in drinking water.

Barium

Barium is a silvery-white metal found in nature and can be produced synthetically. This chemical is typically found in compounds combined with sulfur, carbon, or oxygen and enters the drinking water after dissolving from naturally occurring minerals in the ground. Uses of barium include: oil and gas drilling muds, auto paint, bricks, tiles and jet fuels. The effect on a person's health is greatly dependent on how well the compound dissolves in water. Compounds that do not dissolve well in water are not generally harmful and are often used for medicinal purposes. Ingestion of high-levels result in difficulties in breathing, increased blood pressure, changes in heart rhythm, stomach irritation, brain swelling, muscle weakness, damage to the liver, kidney, heart, and spleen. Symptoms of barium contamination include vomiting, colic, diarrhea, slow irregular pulse, transient hypertension, and convulsive tremors and muscular paralysis. Death may occur in a few hours to a few days. The US DHHS, the IARC, and the EPA have not classified barium as to its human carcinogenicity. The MCL is set at 2 mg/L and the ACGIH TLV is set at 0.5 mg/m^3.

Beryllium

Beryllium in its pure form is a hard, grayish metal with no particular smell. Naturally, it can be found in compounds within mineral rocks, coal, soil, and volcanic dust and enters the drinking water from runoff from mining operations, discharge from processing plants and improper waste disposal. This chemical is often used in electrical equipment and electrical components. Effects of inhalation depend on exposure possibly causing lung damage and a disease resembling pneumonia leading to death. Ingestion of beryllium is not known to

cause effects in humans due to the restriction of movement from the stomach and intestines into the bloodstream. However, it is a deadly poison by intravenous routes. Rashes or ulcers arise from direct contact. The US DHHS has determined that this chemical is a probable human carcinogen. The MCL is set at 0.004 mg/L and the ACGIH TLV is set at 0.002 mg/m³. The NIOSH REL is set at 0.0005 mg/m³.

Bismuth
Bismuth is poisonous to humans. Symptoms often seen include: kidney damage, malaise, albuminuria, diarrhea, skin reactions, exodermatitis, and even death

Boron
Boron is an incredibly toxic material. Symptoms often seen include: irritation of the nose, throat, and eyes, depression of the circulation, persistent vomiting and diarrhea, shock, coma, and even death. Ingestion of large amounts may damage the stomach, intestines, liver, kidney, and brain. Health effects for long-term exposure are not known. The US DHHS, the IARC, and the EPA have not classified the carcinogenicity of boron.

Cadmium
Cadmium is found naturally in the crust, typically as a mineral combined with other elements. This chemical does not corrode easily and is used in batteries, pigments, metal coatings, and plastics. Inhalation of high levels of cadmium will severely damage the lungs and can lead to death. Ingestion of high levels of cadmium irritates the stomach, leading to vomiting and diarrhea. Cadmium will build up in the kidneys, cause damage to the lungs, and creates fragile bones through long-term exposure to lower levels of cadmium. Skin contact with cadmium is not known to cause health effects in humans or animals. Beneficial effects of cadmium are unknown. The US DHHS has determined cadmium and cadmium compounds are probable carcinogens. The MCL is set at 0.005 mg/L and the ACGIH TLV is set at 0.005 mg/m³.

Chromium
Chromium occurs naturally in the ground with no taste or smell associated with this element. This element is found in a few different forms, namely chromium (III) as an essential nutrient and chromium (VI) and chromium (0) typically produced industrially for use in electroplating of metals. Runoff from old mining operations and improper

waste disposal are the modes in which chromium typically enters the groundwater. Inhalation of high-levels of chromium (VI) causes irritations to the nose, such as runny nose, nosebleeds, ulcers, and holes in the nasal septum. Ingestion of high-levels of chromium (VI) can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact also results in skin ulcers. Other symptoms to exposure include severe redness and swelling of the skin in addition to an increased risk of lung cancer. The World Health Organization has determined that chromium (VI) is a human carcinogen. The MCL is set at 0.1 mg/L and the ACGIH TLV is set at 0.5 mg/m^3. The NIOSH REL is set at 0.5 mg/m^3.

Cobalt

Cobalt is a naturally occurring metal that may cause dermatitis or pulmonary damage. This metal is important to human health as a part of vitamin B12 and used to treat anemia. However, high levels of exposure severely affect the lungs. Symptoms often seen from inhalation include: cough, breathing difficulty, wheezing, decreased pulmonary function, weight loss, dermatitis, respiratory hypersensitivity, and asthma. Ingestion of soluble salts produces nausea and vomiting. The IARC has determined that cobalt is a probable carcinogen. The ACGIH TLV and NIOSH REL are set at 0.05 mg/m^3.

Copper

Copper is an essential element for all living things. This metal is also a potentially explosive chemical. Liquid copper explodes on contact with water. Symptoms often seen include: nausea and vomiting, diarrhea, stomach cramps, irritation to the eyes and respiratory system, cough, difficulty breathing, and wheezing. The IARC has determined the carcinogenicity of this chemical is unknown. The ACGIH TLV and NIOSH REL are set at 1 mg/m^3.

Fluoride

Fluoride is a pale, yellow-green gas that has a strong sharp odor. Fluorides are found throughout the environment at very low levels. Inhalation of high-levels of hydrogen fluoride gas causes damage to the lungs and heart and can even lead to death. Low-levels of hydrogen fluoride gas can irritate the eyes, skin, and lungs. Low-levels of sodium fluoride do help reduce tooth cavities, while high levels of sodium fluoride are dangerous to one's health. The carcinogenicity of fluoride has not been determined. The MCL is set at 4 mg/L, but the ACGIH TLV has not been determined.

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Lead
Lead naturally occurs in the crust and is found throughout the environment. This element is used for many purposes and can affect nearly every organ and system of the body. It typically enters the drinking water supply through contact of water with corroded materials containing lead. The effects of inhalation and ingestion are the same; however, the major systems affected by lead poisoning include the nervous system, blood system, and kidneys. Symptoms of lead poisoning include: decreased reaction time, muscle weakness, loss of appetite, anemia, malaise, insomnia, headache, irritability, muscle and joint pains, tremors, flaccid paralysis without anesthesia, hallucinations, and distorted perceptions. Lead poisoning greatly diminishes the intellectual capacity of children, creates delays in normal physical and mental development in babies and young children, and slight deficits in attention span. The US DHHS has determined that more information is needed to determine the carcinogenicity in humans. The MCL has not been determined for this chemical, but the ACGIH TLV has been set at 0.15 mg/m^3. The NIOSH REL is set at 0.05 mg/m^3.

Manganese
Manganese is a naturally occurring metal that is critical to human health in trace amounts. This chemical reacts violently with certain compounds. Symptoms often seen include: degenerative brain changes, change in motor activity, muscle weakness, insomnia, mental confusion, metal fume fever, dry throat, cough, chest tightness, breathing difficulty, vomiting, malaise, kidney damage, and a skin and eye irritant. The carcinogenicity of this chemical is probable. High levels of exposure include: mental and emotional disturbances and slow and clumsy body movements. The EPA has determined the carcinogenicity to be unclassifiable. The ACGIH TLV is set at 5 mg/m^3. The NIOSH REL is set at 1 mg/m^3.

Mercury
Mercury occurs naturally in the environment occupying several forms. The nervous system is greatly affected by this element. High-levels of exposure can lead to permanent damage of the brain, kidneys, and developing fetus. Other limited effects of long-term effects result in irritability, shyness, and tremors, changes in vision or hearing and memory problems. This chemical is corrosive to skin, eyes, and mucous membranes. Symptoms of exposure may include gastrointes-

tinal disturbance, muscle weakness, anorexia, weight loss, headache, tinnitus, hypermotility, diarrhea, liver changes, dermatitis, and fevers. Mercury builds up in the tissues of fish and can then be ingested by humans. The carcinogenic effect of all forms of mercury is unknown. However, the EPA has determined that mercuric chloride and methylmercury are possible human carcinogens. The MCL is set at 0.002 mg/L and the ACGIH TLV is set at 0.05 mg/m³. The NIOSH REL is set at 0.05 mg/m³.

Molybdenum

Molybdenum is a poison and an experimental teratogen. Symptoms often seen in animals include: irritation to the eyes, nose, and throat, anorexia, diarrhea, weight loss, listlessness, liver, and kidney damage. This chemical reacts violently with oxidants. The ACGIH TLV is set at 5 mg/m³.

Nickel

Nickel is an abundant, hard, silvery-white metal found in nature with no characteristic odor or taste. Uses for nickel are expansive and include plating, jewelry, and as catalysts for chemical reactions. Small amounts of nickel are possibly essential to human life. Contact to skin may include allergic contact dermatitis, pulmonary asthma, conjunctivitis, and inflammatory reactions. Inhalation of high-levels of nickel affects the lungs, including chronic bronchitis and reduced lung function. Ingestion of high-levels of nickel affects the stomach, blood, and kidneys. The US DHHS has determined that nickel is a probable carcinogen. The MCL has not been determined for this chemical, but the ACGIH TLV is set at 1 mg/m³. The NIOSH REL is set at 0.015 mg/m³.

Potassium

Potassium is an essential dietary element. This chemical is a dangerous fire hazard. Ingestion of excessive amounts results in kidney failure, nausea, vomiting, abdominal discomfort, diarrhea, heart arrhythmia leading to cardiac arrest., muscular weakness, and temporary paralysis.

Selenium

Selenium is found in the environment in rocks and soil. Inhalation of selenium can result in soreness, coughing, labored breathing, and lung edema. Symptoms of exposure to high-levels include: dizziness, fatigue, irritation, collection of fluid in the lungs, and severe bronchi-

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tis. Ingestion of high-levels could result in irritation to the mouth and throat, in addition to nausea, gastrointestinal disturbance, and vomiting. Other results of exposure include brittle hair, anemia, cirrhosis, deformed nails, and even death. Contact with skin results in rashes, swelling, and pain. Chronic exposure might result in pallor, nervousness, depression, garlic odor of breath and sweat, gastrointestinal disturbances, and dermatitis. The US DHHS has declared that selenium sulfide is a probable carcinogen. The EPA has declared that the carcinogenicity of selenium compounds is not classifiable. The MCL is set at 0.05 mg/L and the ACGIH TLV is set at 0.2 mg/m³. The NIOSH REL is set at 0.2 mg/m³.

Silver

Silver occurs naturally and is typically found in the environment combined with other elements. Uses primarily include jewelry, brazing alloys and solders, disinfectant of drinking water and water in swimming pools, and as an antibacterial agent. Inhalation of high-levels may lead to lung and throat irritation, and stomach pains. Ingestion of high-levels may result in death. Skin contact may result in a rash, swelling, and inflammation. Exposure at low-levels may result in the deposition of silver into the skin. Long-term exposure at high-levels may lead to arygria, a discoloration of the skin and other body tissues. The carcinogenicity of silver is unknown for humans. The MCL is not determined for this chemical, but the ACGIH TLV is set at 0.1 mg/m³. The NIOSH REL is set at 0.1 mg/m³.

Tin

Tin is a natural element in the earth's crust. It is a soft, white, silvery metal that doesn't dissolve in water, Tin is used mainly to make cans. The EPA has limited its use in paints. Large amounts of tin compounds can cause stomachaches, anemia, liver and kidney problems. Breathing or swallowing this chemical can cause breathing problem, eye irritation, and can interfere with the way your brain and nervous system work. In severe cases, it can cause death.

There is no evidence that tin or tin compounds cause cancer in humans or animals, and tin hasn't been classified for carcinogenicity. The MLC hasn't been determined for this chemical. Both the ACGIH TLV and the NIOSH REL are set at 2 mg/m³.

Thallium

Thallium is a radionuclide found in nature. Ingestion of this chemical results in nerve or sheath structural changes, extra-ocular muscle

changes, sweating, and other effects. The MCL is set at 0.002 mg/L and the ACGIH TLV is set at 0.1 mg/m³.

Vanadium

Vanadium has a variable toxicity. Exposure to this chemical results in conjunctivities, rhinitis, reversible irritationism of the respiratory tract, bronchitis, bronchospasms, and asthma-like diseases in more severe cases. The MCL and ACGIH TLV have not been determined for this chemical.

Zinc

Zinc is a skin irritant. Symptoms often seen include: cough, dyspnea, sweating, throat dryness, sweet taste in mouth, cough, weakness, aches, chills, fever, nausea, and vomiting.

Pesticides

After the publication of Rachel Carson's book *Silent Spring* in 1962, concern arose for the use of chemical pesticides entering the food chain. Pesticides are toxic to living organisms and yet little is known about the extent of health effects on humans. Despite the obvious benefit to eradicating disease-carrying and crop-eating insects, the behavior of such chemicals is not completely understood. It is known that pesticides accumulate in fat deposits in the body. A mode of excretion occurs through breast milk, thereby transferring the harmful chemicals ingested from mother to child. Pesticides greatly affect the developing fetus, infants and young children. Health effects resulting from exposure cause serious diseases and disorders, damage to the nervous system, reproductive system and other organs, developmental and behavioral abnormalities, disruption of normal hormonal function, and immune dysfunction.

Acrylonitrile

Acrylonitrile is synthetic material used to make other chemicals. In the past, acrylonitrile was combined with carbon tetrachloride for use as a pesticide. Symptoms often seen include: conjunctive irritation, somnolence, general anesthesia, cyanosis, diarrhea, increased salivation, photophobia, deepened respiration, nausea, vomiting, weakness, headache, jaundice, anemia, nose and eye irritant, and leucocytosis. The effect that this chemical has on the human body in-

hibits respiratory enzymes of tissue and renders the tissue cells incapable of oxygen absorption. This chemical is carcinogenic. The US DHHS has determined that acrylonitrile is a probable carcinogen. The ACGIH TLV is set at 2 ppm. The NIOSH REL is set at 1 ppm.

Aldrin and Dieldrin
Aldrin and Dieldrin are chemicals that are similar in nature and in effect on humans. In pure form, both are white powders with a mild chemical odor and do not occur naturally in the environment. Aldrin quickly breaks down into dieldrin in the body and in the environment. By 1987 all uses of these chemicals were banned, including the use as a pesticide and for termite control. These chemicals mainly affect the central nervous system. Ingestion of significantly high-levels of these chemicals results in buildup, convulsions, coma and even death. The effects of low-levels of exposure include headaches, dizziness, vomiting, irritability, uncontrolled muscle movements. The IARC has determined that both aldrin and dieldrin are not classifiable as to their carcinogenicity to humans. The MCL has not been determined for these chemicals. The ACGIH TLV and NIOSH REL for both aldrin and dieldrin is set at 0.25 mg/m^3.

Alpha BHC
Alpha BHC, also known as Benzene Hexachloride-alpha-isomer, is a poison by ingestion. This chemical is a confirmed carcinogen with experimental carcinogenic, tumorigenic, and neoplastigenic data. The MCL and ACGIH TLV have not been determined for this chemical.

Beta BHC
Beta BHC is also known as trans-alpha-benzenehexachloride. This chemical is a confirmed carcinogen with experimental neoplastigenic data. Ingestion of Beta BHC is mildly toxic. The MCL and ACGIH TLV have not been determined for this chemical.

Chlordane
Chlordane is a thick liquid whose color ranges from colorless to amber with a mild and irritating smell that was manufactured for use as a pesticide. Uses of this chemical were completely banned in 1988 by the EPA. Although chlordane is not very mobile in soils, it is known to enter the drinking water after application on crops near the water supply intakes or well. Exposure to this chemical affects the nervous system, digestive system, and the liver. It has been found that chlordane lacks the ability to disrupt hormones by itself but greatly

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magnifies the ability of other chemicals to disrupt hormones. Inhalation of high-levels of chlordane include: headaches, irritability, confusion, weakness, vision problems, vomiting, stomach cramps, diarrhea, and jaundice have occurred in people who breathed air containing high concentrations of chlordane or accidentally swallowed small amounts of chlordane. Ingestion of high-levels leads to convulsions and death. The IARC has determined that chlordane is not classifiable as to its carcinogenicity to humans. The MCL is set at 0.002 mg/L and the ACGIH TLV and NIOSH REL are set at 0.5 mg/m^3.

DDD

DDD, also known as 1,1-bis(4-chlorophenyl)-2,2-di-chloroethane, was once used as a pesticide. Uses for this chemical have been banned. This chemical contaminates DDT products and DDT typically breaks down into DDE or DDD. The nervous system is greatly affected. Symptoms often seen include: excitability, tremors, and seizures. Ingestion results in poisoning. The US DHHS has not determined the carcinogenicity for DDD. This pesticide is a known carcinogen.

DDE

DDE, also known as 2,2-Bis(p-Chlorophenyl)-1,1-Di-Chloroethylene, sometimes is a contaminant for DDT products with no commercial use. The US DHHS has not classified DDE as to the carcinogenicity to humans. The EPA has determined that this chemical is a probable carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

DDT

DDT, also called 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane, is a manufactured chemical used as a pesticide. This chemical is a white, crystalline solid with no odor or taste. The use of this chemical was banned in the United States, aside from public health emergencies. Symptoms of exposure may include irritation to the eyes and skin, anxiety, dizziness, confusion, discomfort, headache, weakness and exhaustion, convulsions, vomiting, excitability, tremors, and seizures. Long-term exposure to this chemical affects the nervous system and results in changes in the levels of liver enzymes. The US DHHS has determined that this chemical is a probable human carcinogen. The MCL has not been determined for this chemical, but the ACGIH TLV is set at 1 mg/m^3. The NIOSH REL is set at 0.5 mg/m^3.

Di-n-butyl phthalate
Di-n-butyl phthalate exposure symptoms often seen include: eye, stomach, and upper respiratory irritation, hallucinations, distorted perceptions, nausea or vomiting, and kidney, ureter or bladder changes. The ACGIH TLV and NIOSH REL are set at 5 mg/m^3.

Dicamba
Dicamba, also known as 2-Methoxy-3,6-Dichlorobenzoic Acid, is moderately toxic by ingestion. The MCL and ACGIH TLV have not been determined for this chemical.

1,2-Dichloroethane
1,2-Dichloroethane, also known as ethylene dichloride, is a synthetic chemical that is used to make other chemicals. Symptoms often seen include: somnolence, cough, jaundice, nausea or vomiting, hypermotility, diarrhea, ulceration or bellding from the stomach, fatty liver degeneration, change in cardiac rate, cyanosis, coma, dermatitis, edema of the lungs, toxic effects on the kidneys, and severe corneal effects. The US DHHS, the IARC and the EPA have not classified the carcinogenicity of this chemical. The ACGIH TLV is set at 10 ppm. The NIOSH REL is set at 1 ppm.

Dinoseb
Dinoseb, also known as 2-sec-Butyl-4,6-dinitrophenol, is a widely used herbicide. This chemical enters the drinking water after application on orchards, vineyards, and other crops. This chemical is a poison by ingestion and a severe irritant to the eyes. Pathways the chemical may travel into the body include: skin contact, subcutaneous, and intraperitoneal routes. The carcinogenicity is questionable with experimental tumorigenic data. The MCL is set at 0.007 mg/L for the chemical, while the ACGIH TLV has not been determined.

Endosulfan II
Endosulfan II is a pesticide and wood preservative found in solid form as crystals or flakes. This chemical smells similar to turpentine and does not burn. This chemical affects the central nervous system but does not accumulate significantly in human tissue. Symptoms of exposure may include irritation to the skin, hyperactivity, nausea, dizziness, headache, tremors, or convulsions, and even death may occur. The carcinogenicity of this chemical is unknown. The MCL has not been determined for this chemical, but the ACGIH TLV and NIOSH REL are set at 0.1 mg/m^3.

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Endothall
Endothall is a poison extremely irritating to skin, eyes, and mucus membranes. Symptoms often include: diarrhea.

Endrin
Endrin is a pesticide that is a solid, white, almost odorless substance that is banned from use in the United States. This chemical accumulates in sediments and aquatic and terrestrial biota. Exposure to endrin can cause various harmful effects including death and severe central nervous system (brain and spinal cord) injury. Ingestion of this chemical may cause convulsions and will kill you in a matter of minutes to a matter of hours. This chemical does not accumulate in human tissue. Symptoms resulting from exposure include headaches, dizziness, nervousness, confusion, nausea, vomiting, and convulsions. Effects of inhalation or contact are not known. The EPA has declared the human carcinogenicity to be unknown. The MCL is set at 0.002 mg/L and the ACGIH TLV and NIOSH REL are set at 0.1 mg/m^3.

Gamma-chlordane
Gamma-chlordane is no longer permitted for use as a termiticide or pesticide. Symptoms often seen include: tremors, convulsions, excitement, diarrhea, jaundice, vomiting, stomach cramps, vision problems, ataxia, central nervous system stimulant, and gastritis. The IARC has not determined the carcinogenicity of this chemical. The ACGIH TLV and NIOSH REL are set at 0.5 mg/m^3.

Heptachlor and Heptachlor Epoxide (Epoxyheptachloris)
Heptachlor and Heptachlor Epoxide (Epoxyheptachloris) are manufactured chemicals found as a white powder that smell like camphor (mothballs). Heptachlor breaks down into heptachlor epoxide. These chemicals were used primarily as insecticides until 1988. Ingestion of heptachlor results in dizziness, confusion, or convulsions. The full extent of heptachlor and heptachlor epoxide poisoning are unknown for humans, other than damage to the nervous system. Low-levels of exposure have caused liver damage and the symptoms include tremors, convulsions, kidney damage, respiratory collapse, and death. The IARC has determined that heptachlor and heptachlor epoxide are not classifiable to their carcinogenicity to humans. The MCL for heptachlor is set at 0.0004 mg/L and the MCL for heptachlor epoxide is set at 0.0002 mg/L. The ACGIH TLV has not been determined for these chemicals. The NIOSH REL is set at 0.5 mg/m^3.

Heptachlorinated dibenzo-p-dioxins
Heptachlorinated dibenzo-p-dioxins is a type of dioxin. Dioxins are understood to function in a similar manner as a steroid hormone. This implies that the dioxins enter the body and bind to a protein. A complex is then formed that attaches to the cell's chromosomes, thereby altering the genetic material and affecting the body in many different ways. The MCL and ACGIH TLV have not been determined for these chemicals.

Isopropanol
Isopropanol is also known as Isopropyl alcohol and is a moderately toxic chemical. Symptoms often seen include: flushing, pulse rate decrease, blood pressure lowering, anesthesia, narcosis, headache, dizziness, mental depression, drowsiness, hallucinations, distorted perceptions, dyspnea, respiratory depression, nausea or vomiting, and coma. The ACGIH TLV and NIOSH REL are set at 400 ppm.

Lindane
Lindane, also known as benzene hexachloride, is a pesticide that mimics natural hormones. Under favorable soil and climatic conditions, lindane enters the drinking water through runoff of contaminated materials into surface water or by leaching into the groundwater. Inhalation results human systemic effects by headache, nausea or vomiting, and fever. Pathways taken by this chemical into the body include: ingestion, skin contact, and subcutaneous routes. This chemical is more toxic than DDT or dieldrin and is shown to damage the nervous system and circulatory system. Lindane is a confirmed carcinogen with experimental carcinogenic, neoplastigenic, and tumorigenic data by ingestion and skin contact. The MCL is set at 0.0002 mg/L, but the ACGIH TLV has not been determined for this chemical.

Methylene chloride
Methylene chloride is a synthetic material that is also a severe skin and eye irritant. Symptoms often seen include: dizziness, nausea, decreased attentiveness, paresthesia, somnolence, altered sleep time, convulsions, euphoria, change in cardiac rate, and a severe eye and skin irritant. The US DHHS, the WHO, and the EPA have determined that methylene chloride is a probable carcinogen. This chemical is a known carcinogen. The ACGIH TLV is set at 50 ppm.

Napthalene
Napthalene is a naturally occurring material typically used to make the insecticide carbaryl. Symptoms often seen include: damage to red blood cells, fatigue, lack of appetite, restlessness, nausea, skin and eye irritant, headache, diaphoresis, hematuria, fever, anemia, liver damage, vomiting, renal shutdown, corneal damage, convulsions, and coma. The US DHHS, the IARC, and the EPA have determined the carcinogenicity of this chemical is not classifiable. The ACGIH TLV and NIOSH REL are set at 10 ppm.

Pentachlorophenol
Pentachlorophenol is a synthetic chemical that is extremely dangerous and was used as a pesticide. Symptoms often seen include: acute poisoning marked by weakness, changes in respiration, blood pressure, and urinary output, dermatitis, convulsions and collapse, anorexia, weight loss, sweating, headache, dizziness, nausea, vomiting, breathing difficulty, chest pain, and liver and kidney injury. The EPA and the IARC have determined this chemical to be a probable carcinogen. This chemical is a known carcinogen. The ACGIH TLV and NIOSH REL are set at 0.5 mg/m^3.

Phenol
Phenol is a synthetic chemical that was widely used as a pesticide. Symptoms often seen include: severe eye and skin irritation, kidney, liver, pancreas, and spleen damage, edema of the lungs, anorexia, weight loss, weakness and exhaustion, muscle ache, pain, corrosion of the lips, mouth, throat, esophagus and stomach, gangrene and even death. The carcinogenicity of this chemical is unknown. The ACGIH TLV and NIOSH REL are set at 5 ppm.

Toxaphene
Toxaphene, also known as Chlorinated Camphene, is an insecticide that mimics natural hormones. Ingestion and skin contact result in somnolence, convulsions or effect on seizure threshold coma, and allergic skin dermatitis. Symptoms of exposure may include nausea, confusion, agitation, tremor, convulsions, unconsciousness, or dry and red skin. Carcinogenicity of toxaphene is probable. The MCL is set at 0.003 mg/L and the ACGIH TLV is set at 0.5 mg/m^3.

2,4,5-TP
2,4,5-TP, also known as (2,4,5-Trichlorophenoxyl)Proprionic Acid, is commonly referred to as Silvex. Ingestion results in poisoning.

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The carcinogenicity of Silvex is probable. The MCL is set at 0.05 mg/L, but the ACGIH TLV has not been determined.

2,4,5-T

2,4,5-T, also known as 2,4,5-trichlorophenoxyacetic acid, is readily absorbed through inhalation and ingestion and slowly through contact. Effects of exposure include: weakness, lethargy, anorexia, diarrhea, ventricular fibrillation. Chronic exposure can result in cardiac arrest and even death. The MCL has not been determined, but the ACGIH TLV and NIOSH REL are set at 10 mg/m^3.

Xylene

Xylene is a naturally occurring material in petroleum and coal tar. This chemical is a severe skin and eye irritant and greatly affects the brain. Symptoms often seen include: olfactory changes, conjunctiva irritation, pulmonary changes, headaches, lack of muscle coordination, dizziness, confusion, difficulty breathing, and gastrointestinal discomfort. This chemical is a dangerous fire hazard when exposed to heat or flame. The IARC has determined the carcinogenicity of this chemical is not classifiable. The ACGIH TLV is set at 100 ppm.

o-Xylene

o-Xylene, also known as 1,2-Dimethylbenzene, is a mildly toxic chemical. This chemical is a very dangerous fire hazard when exposed to heat or flame. Symptoms often seen include: irritation to the eyes, skin, nose, and throat, dizziness, excitement, drowsiness, incoordination, staggering gait, corneal vacuolization, anorexia, nausea, vomiting, abdominal pain, and dermatitis. The ACGIH TLV and NIOSH REL are set at 100 ppm.

Radionuclides

Radionuclides are atoms with structures that are out of balance. The atoms are continually changing, or decaying, into a more stable form. The decay process releases energy, otherwise known as radiation. Any alteration to the delicate balance that atoms maintain affects the structure and stability of the cell. As radiation strikes an atom, the balance is disrupted and the atom gains a positive or negative charge. These atoms are called ions and the ionization of atoms and molecules inside a living cell results in damage to the cell.

Ionizing radiation results in health problems. There are three important types of radiation that cause ionizing radiation: alpha and beta particles, and gamma rays. Alpha particles are large enough particles that the outer layer of dead skin will prevent the penetration of alpha particles into the human body. However, if an alpha particle does indeed enter into the lungs, the ionizing energy will break through cell walls. These particles have a charge of +2. The positive charge enables these particles to be effective ionizers that travel at relatively slow speeds and short ranges.

Beta particles are smaller negatively charged particles that are the equivalent to electrons. These particles originate in the nucleus whereas electrons originate outside the nucleus. Although beta particles are not radioactive, the atoms that emit the particles are. The energy and speed result in damage to cells. Solid objects stop these particles easily.

Gamma rays have incredibly high energy and can easily pass through lead and several feet of concrete. These particles don't need to be ingested or inhaled to seriously damage the human body.

Damage brought about by exposure to radioactivity results in cancer. All radionuclides are known carcinogens. In regards to other chemicals, the carcinogenicity is not always certain.

Plutonium
Plutonium is a radionuclide that is extremely dangerous. Plutonium-236 is an alpha emitter. The high radiotoxicity of plutonium determines the toxicity of plutonium compounds in addition to other atoms in the compounds they form. Any event that further spreads this radionuclide into the environment is dangerous to the life and land. This chemical was created expansively in nuclear weapons production and nuclear power plants. The MCL is set at 15 pCi/L.

Strontium
Strontium is a radionuclide with similar properties to calcium. Strontium-90 is a beta emitter. The stable form has low toxicity and ignites spontaneously in air. When strontium is combined with water or steam, it reacts vigorously to evolve into hydrogen. The MCL is set at 50 pCi/L.

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Thorium
Thorium is a radionuclide found in nature. Thorium -232 is an alpha emitter. The carcinogenicity of thorium is probable. The MCL is set at 15 pCi/L.

Tritium
Tritium is a radionuclide that is not an external radiation hazard. This radionuclide is an alpha emitter. When tritiated water is ingested, the blood distributes the materials equally among all of the body fluids. As a human is exposed to tritium, the soft tissues are irradiated. The MCL is set at 20,000 pCi/L.

Uranium
Uranium is a radionuclide found in the environment that is highly toxic on an acute basis. Uranium-238 is an alpha emitter. Exposure at high-levels to uranium results in kidney damage, acute arterial lesions, and cancer. Soluble uranium compounds can be absorbed rapidly into the body. The MCL is set at 20 µg/L and the ACGIH TLV is set at 0.2 mg/m³.

ENDNOTES

[1] Rachel's Environmental Health News, #640 – Chlorine Chemistry News, March 04, 1999.

[2] Rachel's Environmental Health News, #498 – Dangers of Chemical Combinations, June 13, 1996.

[3] http://www.environhealthaction.org/toxics/heavy_metals/

APPENDIX 1. Abbreviations and Acronyms

ACGIH – American Conference of Governmental Industrial Hygienists
ATSDR – Agency for Toxic Substances and Disease Registry
DHHS – Department of Health and Human Services
DOE – U.S. Department of Energy
EPA – Environmental Agency
FDA – Food and Drug Administration
HR – Hazard Rating
IARC – International Agency for Research on Cancer
MCL – Maximum Contaminants Levels (mg/L)
NIOSH – National Institute for Occupational Safety and Health
OSHA – Occupational Safety and Health Administration
The OSHA sets permissible exposure limits (PELs) to protect workers against adverse health effects resulting from exposure to hazardous substances.

PAH – Polycyclic Aromatic Hydrocarbon
PCB – Polychlorinated biphenyl
pCi – pico-Curies, measurement of radioactivity
PELs – Permissible Exposure Limits
The PELs determined hazardous substances are enforceable, regulatory limits on allowable indoor air concentrations.

PETN – Pentaerythritol tetranitrate
REL – Recommended Exposure Level
SMCL – Secondary Maximum Contaminants Levels (mg/L)
TLV – Threshold Limit Value
WHO – World Health Organization

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APPENDIX 2. Glossary

- **Anemia:** A decreased ability of the blood to transport oxygen
- **Carcinogen:** Any substance that produces or promotes cancer
- **Carcinogenicity:** Ability to cause cancer
- **Irritant:** Abnormal reaction to a substance
- **Long-term:** 365 days or longer
- **Milligram (mg):** One thousandth of a gram
- **Tumor:** An abnormal mass of tissue

APPENDIX 3. Bibliography

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Lewis, Richard J. "Hazardous Chemicals Desk Reference," 1993.

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Office of Water, US EPA. "Drinking Water Standards and Health Advisories", EPA 822-B-00-001, Summer 2000.

S.M. Stoller Corporation. "Final FY 2000 Summary and Progress Report for Groundwater Investigations at DOE Pantex Plant", Volume 1. January 29, 2001.

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ESER Program. "Gross Alpha Radiation", "Gross Beta Radiation". <http://www.stoller-eser.com/FactSheet/>.

National Institute for Occupational Safety and Health. "NIOSH Pocket Guide to Chemical Hazards", <http://www.cdc.gov/niosh/npg/npg.html>.

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US EPA. "Current Drinking Water Standards", January 23, 2002, <http://www.epa.gov/safewater/mcl.html>.

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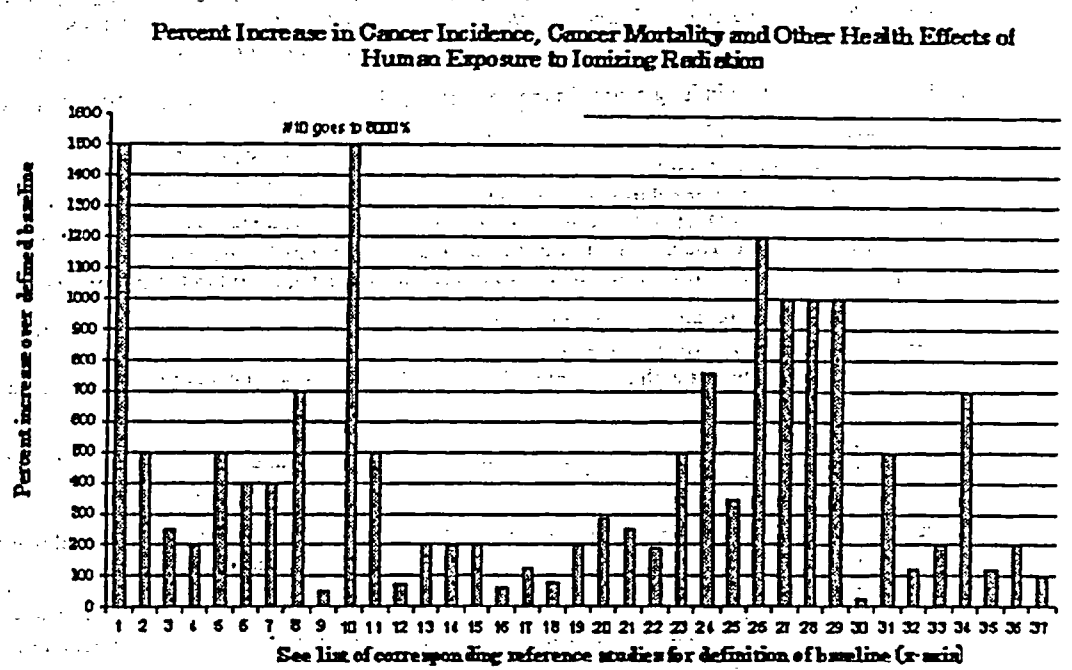
US EPA. "List of Contaminants and MCLs", <http://www.epa.gov/safewater/mcl.html>, <http://www.epa.gov/safewater/regs/cfr141.pdf>.

WHO. "Guidelines for drinking water quality." <http://www.who.int/water_sanitation_health/GDWQ/>.

Reigart, J. & Roberts, J. "Recognition and Management of Pesticide Poisonings", Fifth Edition, 1999: <http://www.epa.gov/oppfead1/safety/healthcare/handbook/handbook.pdf>.

http://www.gis.usu.edu/~sanduku/papers/gisca/node14.html



Legend for "Percent Increase in Cancer Incidence, Cancer Mortality, and Other Health Effects of Human Exposure to Ionizing Radiation"

1. 1500% increase in incidence of testicular and ovarian cancer in children on Navaho reservation in uranium mining area
2. 500% increase in bone cancer in children affected by uranium
3. 250% increase in leukemia (all ages) in the Navaho population
4. 200% increase in each of the following non-cancer effects: miscarriage, infant death, congenital defects, genetic abnormalities, learning disorders.
   Baseline for 1-4: Navajo residents living near Uranium facilities were compared to Navajo resider in non-uranium areas

5. 500% increase in birth defects when compared to the national average.
   (Southwest Research and Information Center. "Uranium Legacy." *The Workbook*, v 8, no 6. Albuquerque, NM: 1983.)

6. 400% increase in leukemia incidence in the population living downwind of the Pilgrim nuclear pov reactor in Massachusetts in the first 5 years after fuel was know to have leaked excess radioactivity **Baseline:** Disease in population before and after Pilgrim radioactive releases and comparison to

upwind population.
(Morris M. Knorr R. *The Southeastern Massachusetts Health Study 1978-1986-Report of the Massachusetts Department of Public Health.* October 1990. See also: Clapp R. Cobb S. et al. "Leukemia Near Massachusetts Nuclear Power Plant." Letter in *Lancet.* December 5, 1987.)

7. 300—400% increase in lung cancer in the general population within the plume of the Three Mile Island accident releases
8. 600—700% increase in leukemia in the general population within the plume of Three Mile Island accident releases **Baseline:** Disease in population upwind (out of the radiation plume path) is compared to disease in population downwind (in the pollution plume.)
(Wing S. Richardson D. et al. "A Reevaluation of Cancer Incidence Near the Three Mile Island Nuclear Power Plant: The Collision of Evidence and Assumptions." *Environmental Health Perspectives*, v 105, no 1. National Institutes of Health. Bethesda, Maryland. January 1997.)

9. 50% increase in childhood cancer incidence in the Three Mile Island area for each 10 millirem increase in radiation exposure per year.
Baseline: Children living with different radiation levels are compared for evidence of disease.

(Hatch M. et al. "Background Gamma Radiation and Childhood Cancers Within Ten Miles of a US Nuclear Power Plant." *International Journal of Epidemiology*, v 19, no 3. 1990.)

10. 8000% increase in thyroid cancer in Belarussian children living near Chernobyl, reported 6 years a the meltdown.
Baseline: Comparison of population health before and after the Chernobyl explosion.
(Hudson RL. "Child Cancers Found to Rise Near Chernobyl." The Wall Street Journal. September 1992. *The article they quote was published in Nature on the same day and was researched by the World Health Organization.*)

Further effects found in victims of the Chernobyl accident less than ten years after the meltd
11. 500% increase in thyroid cancer in Ukrainian children.

12. 75% increased incidence of heart disease
13. 200% increase in respiratory and digestive disease
14. 200% increase in birth defects
15. 200% increase in spontaneous abortions
Baseline: Comparison of population health before and after the Chernobyl explosion
(Rupert J. "Illness Tied to Disaster Still on Rise." The Washington Post. June 24, 1995. *The reporte was quoting Britain's Imperial Cancer Research Fund, The Ukrainian Health Ministry and the Un Nations.*)

16. 63% increase in leukemia incidence among workers at Oak Ridge National Laboratories(US) who received very low doses of external (gamma) radiation on the job.
17. 123% increase in leukemia incidence in the same population where there were also very low intern doses of radioactivity
Baseline: Cohort comparison of worker deaths and radiation exposure levels
(Wing S. Shy C. et al. "Mortality Among Workers at Oak Ridge National Laboratory: Evidence of Radiation Effects in Follow-up Through 1984." *JAMA*, v 265 no 11. March 20, 1991.)

18. 80% increase in eight types of cancer deaths in Department of Energy atomic workers exposed to

external doses of radiation. **Baseline:** Various baselines. Usually cohort comparison of workers wi various doses and their deaths from resulting diseases were used.
(Mancuso TF. Stewart A. Kneale G. "Radiation Exposures of Hanford Workers Dying From Canc and Other Causes." *Health Physics*, v 33. Pergamon Press, Great Britain. November 1977.)

19. 200% increase in leukemia in children of atomic workers **Baseline:** The parents of children with cancer were compared for occupation to discern if those adults who worked with radiation had mo children with cancer than those who worked in other jobs.
(Roman E. et al. "Case-control Study of Leukemia and Non-Hodgkin's Lymphoma Among Childn Aged 0-4 years Living in West Berkshire and North Hampshire Health Districts." *BMJ* 1993 #306.

20. 287% increase in cancer incidence in children of nuclear workers who received internal radiation i England
Baseline: The parents of children with cancer were compared for occupation to discern if those ad who worked with radiation had more children with cancer than those who worked in other jobs.
(Sorahan T. Roberts PJ. "Childhood Cancer and Paternal Exposure to Ionizing Radiation: Prelimin Findings From the Oxford Survey of Childhood Cancers." *American Journal of Industrial Medicin* 23: 343-354. 1993.)

21. 250% increase in all cancers among atomic workers
22. 190% increase in leukemia incidence
Baseline: General Population
(Kendall. GM. et al. "Mortality and Occupational Exposure to Radiation: First Analysis of the National Registry for Radiation Workers." *BMJ* v 304: 220-5. 1992.)

23. 500% increase in childhood leukemia in children visiting the beach once a week near the French nuclear reprocessing facility at LaHague
24. 760% increase in childhood leukemia if they ate the local fish regularly
25. 345% increase in childhood leukemia associated with drinking well water from the vicinity of the nuclear facility
Baseline: Observed leukemia cases were compared to expected leukemia cases.
(Viel JF. Pobel D. Incidence of Leukaemia in Young People Around the La Hague Nuclear Waste Reprocessing Plant: A Sensitivity Analysis." *Statistics in Medicine*, v 14: 2459-2472. 1995.)

26. 1200% increase in all cancers exist around the Sellafield, (formerly Windscale) reprocessing facili and of these,
27. 600-1000% increase in leukemia of children whose fathers were exposed to certain amounts of radiation prior to conception
28. 1000% increase in lymphoma was found in children near a reprocessing facility in Cumbria
Baseline: Local and Area Controls
(Gardner et al. "Results of Case-control Study of Leukemia and Lymphoma Among Young People Near Sellafield Nuclear Plant in West Cumbria." *BMJ* v 300. February 17, 1990.)

29. 1000% increase in leukemia incidence in children living near a nuclear reprocessing facility
Baseline: Children of the same age in the same area prior to the facility's operation.
(Heasman et al. "Childhood Leukemia in Northern Scotland." *Lancet*, v 1:266. 1986.)

30. 27.3% increase in all cancer deaths among atomic workers exposed to internal doses of radiation
Baseline: Comparison of worker deaths and radiation exposure levels.
(Morgenstern H. Froines J. Epidemiologic Study to Determine Possible Adverse Effects to Rocketdyne/Atomics International Workers from Exposure to Ionizing Radiation. State of Californ

Health and Welfare Agency. June 1997.)

31. 500% increase in leukemia among Utah nuclear bomb test Downwinders
32. 121% increase in thyroid cancer incidence in the same group
33. 200% increase in breast cancer
34. 700% increase in bone cancer
    Baseline: Utah Mormons exposed to bomb fallout are compared to all Utah Mormons.
    (Johnson CJ. "Cancer Incidence in an Area of Radioactive Fallout Downwind From the Nevada Te Site." JAMA, v 251 n 2: 231-6. January 13, 1984.)

35. a greater then 120% increase in thyroid cancer in those who drank milk laced with Iodine-131 fron atmospheric nuclear weapons tests
    Baseline: Estimated cases are based on dose reconstruction where estimated exposures were betwe 6-112 rads per individual child in the bombs' plumes.
    (Ortmeyer P. Makhijani A. "Let Them Drink Milk." *The Bulletin of the Atomic Scientists*, Nov/Dec 1997.)

36. 200% increase in lung cancer in women who received radiation treatments for breast cancer
    Baseline: Breast cancer patients treated with radiation were compared to those who were treated o by other methods.
    (Bishop JE. "Study Links Breast Cancer Treatment to Higher Risk of the Disease in Lungs." The V Street Journal, May 14, 1993: B6.)

37. 66—96% increase in early cancer deaths due to background radiation
    Baseline: Deaths of children living with different radiation levels are compared for cancer.
    (Kneale GW. Stewart AM. "Childhood Cancers in the UK and their Relation to Background Radiation." *Radiation and Health*. 1987.)

This list was compiled by Cindy Folkers & Mary Olson on 4/24/98, Nuclear Information & Resource Service, 1424 16 th St, NW Suite 404, Washington, DC 20036 (202)328-0002 -- it is arbitrarily based on what studies are on file at NIRS.

A partial list of non-cancer health effects of human exposure to radiation:

Downs Syndrome
Hydrocephaly
Microhydrocephaly
Cleft Lip and Palate
Epilepsy
Kidney and Liver Damage
Thyroid Disease
Low Birthweight
Increased Infant Mortality
Increased Stillbirth
Genetic Mutations/Chromosomal Aberrations
Spinal Defects
Congenital Malformations

RJB received 3/29/05

From: <NancyBurtonEsq@aol.com>
To: <rle@nrc.gov>
Date: 3/21/05 12:13PM
Subject: Millstone - Notice of Intent to Sue

12/9/04
69 FR 71437
(59)

Mr. Emch:
Please include this message and the attachmnent in your EIS review.
Thank you.
Nancy Burton

CONNECTICUT COALITION AGAINST MILLSTONE
www.mothballmillstone.org (http://www.mothballmillstone.org)

COALITION ANNOUNCES SUIT AGAINST MILLSTONE;
CHARGES ILLEGAL DISCHARGES ENDANGER HEALTH AND ENVIRONMENT

For Immediate Release: March 21, 2005
Contact: Nancy Burton 203-938-3952

Waterford – The Connecticut Coalition Against Millstone announced today it will bring a federal lawsuit to stop alleged illegal discharges of chemical and radioactive waste into the Long Island Sound by the Millstone Nuclear Power Station.

The Coalition served Dominion Nuclear Connecticut, Inc., owner and operator of the nuclear facility, with a formal notice of intent to sue, a legal pre-requisite to bring a federal lawsuit under the provisions of the Federal Clean Water Act.

The Coalition's notice alleges that permits issued by Connecticut's Department of Environmental Protection have expired, were issued beyond DEP's authority and were illegally transferred to Dominion by Northeast Utilities in 2001.

"Dominion and its predecessor, Northeast Utilities, have treated the Long Island Sound as if it were their private nuclear and toxic waste dump," said Nancy Burton, a Coalition leader.

"With this lawsuit, Dominion's dumping days will be over," Burton said.

The Coalition listed 38 radioactive isotopes and 146 metals and chemicals – many of them carcinogens – which are believed to be routinely discharged into the Long Island Sound under permits which have expired or are illegal.

"The Long Island Sound would be spared contamination by these deadly radioactive and toxic agents if the government ordered Millstone to convert to a closed cooling system such as we have advocated since 1999," Burton said.

"The links between Millstone's effluent discharges – which are washed by the tides and currents onto the shorelines of Waterford and East Lyme - and human health effects are established," Burton said.

On March 10, 2005, at a press conference convened by the Coalition, Dr. Helen Caldicott, a world-recognized authority on the health effects of low-level ionizing radiation, publicly linked Millstone effluents with the rare jawbone cancer found in Zachary M. Hartley when he was born on December 16.

SISP Review Complete
Template = ADM-013

E-RIDS = ADM-03
Add = R.J. Emch (RLE)

1997.

Zachary's mother swam daily during critical months of her pregnancy at the Hole-In-the-Wall beach on Niantic Bay 1.5 miles from Millstone's discharge point.

Under the permits which the Coalition says have expired and were illegally issued, Millstone is permitted to discharge radioactive and toxic chemical effluents at heightened concentrations to a "mixing zone" which is defined as the area in Long Island Sound within 8,000 feet – or roughly 1.5 miles – from its discharge point.

One radionuclide – cesium-137, which Dr. Caldicott identified as a possible factor in Zachary's jawbone cancer – was found in a fish caught by NU in Niantic Bay in 1997, the year of Zachary's gestation. NU admitted the contamination originated from its effluent releases.

The Coalition is investigating other instances of cancers which have developed in people who have swum and sunbathed on the Niantic and Waterford shorelines near Millstone.

Note to Editors: The Coalition's Notice of Intent to Sue (10 pages) is attached.

- 30 -

CC: <ajk1@nrc.gov>, <secy@nrc.gov>

CONNECTICUT COALITION AGAINST MILLSTONE

www.mothballmillstone.org

March 21, 2005

Dominion Nuclear Connecticut, Inc.
Millstone Nuclear Power Station
314 Rope Ferry Road
Waterford CT 06385

Dominion Generation
P.O. Box 26666
Richmond VA 23261

Re: Notice of Intent to Sue

Dear Sirs:

The Connecticut Coalition Against Millstone ("the Coalition") is an organization uniting statewide clean-energy groups, Millstone whistleblowers and families and individuals who reside in Connecticut and elsewhere, including within the emergency evacuation zone of the Millstone Nuclear Power Station ("Millstone").

Section 505(b) of the Clean Water Act ("CWA"), 33 U.S.C. Section 1365(b) requires that sixty days prior to filing a citizen suit in federal court under section 505(a) of the CWA, 33 U.S.C. Section 1365(a), the alleged violators, the U.S. Environmental Protection Agency and the state in which the alleged violations occur be given notice of the alleged violations.

MPS-83-1 The Coalition hereby places Dominion Nuclear Connecticut, Inc. and Dominion Generation and their related Dominion corporate entities (collectively, "Dominion") on notice pursuant to section 505(b) of the CWA, 33 U.S.C. section 1365(b), that it believes that Dominion has violated and continues to violate "an effluent standard or limitation" under section 505(a)(1)(A) of the CWA, 33 U.S.C. Section 1365(a)(1)(A), by failing to comply with National Pollution Discharge Elimination System ("NPDES") permit number CT0003253, issued

1

MPS-83-1 pursuant to section 402(b) of the CWA, 33 U.S.C. Section 1342(b) by the Connecticut Department of Environmental Protection ("DEP") pursuant to authority delegated to it.

MPS-83-2 Based on records maintained by the DEP, the Coalition believes that Dominion has discharged and will continue to discharge pollutants into the Long Island Sound in violation of effluent standards or limitations of the NPDES permit issued on December 15, 1992 in one or more of the following ways:

1. NPDES permit number CT0003253 expired on December 14, 1999 and has been of no lawful effect since such date; accordingly, all effluent discharges otherwise permitted under the terms of the permit since such date have occurred in violation of the CWA effluent standards and limitations;

2. The DEP, commencing on or about 1998 and consistently thereafter, has issued and renewed "emergency authorizations" for indefinite periods purportedly pursuant to Connecticut General Statutes Section 22a-6(k) for purposes of permitting effluent discharges otherwise disallowed by the 1992 NPDES permit which expired on December 14, 1997 and all in the absence of notice to the public and an opportunity for meaningful public comment; accordingly, all effluent discharges released pursuant to said "emergency authorizations" since 1998 have occurred in violation of CWA effluent standards and limitations. The most recent such "emergency authorization" ("EA"), which is of indefinite duration, was issued by DEP on October 20, 2000 and has been "in effect" since such date;

3. On or about April 1, 2001, DEP purported to authorize the transfer of NPDES permit number CT0003253 and the "EA" from the Northeast Nuclear Energy Company ("NNECO") to Dominion; subsequent thereto, NNECO "transferred" the expired NPDES permit number CT0003253 and the EA to Dominion;

4. Insofar as DEP lacked lawful authority to transfer the expired NPDES permit and to transfer the EA, insofar as such EA had been issued initially in the absence of legal authority, all

effluent discharges released by Dominion since April 1, 2001 into the Long Island Sound have occurred without legal authority and in violation of CWA effluent standards and limitations;

5. It appears that DEP issued the EA and its predecessor "emergency authorizations" in knowing violation of the law, Connecticut General Statutes Section 22a-6(k), which limits the issuance of emergency authorizations to address discrete events involving "an imminent threat to human health or the environment" and not for terms of unlimited duration;

6. On or about December 20, 1999, Arthur J. Rocque, Jr., then-DEP Commissioner, authorized renewal of one such "emergency authorization" concerning discharges from the Millstone Unit 3 nuclear reactor after noting as follows:

   "I really hate these [NNECO requests for renewal of emergency authorizations]. Statutes are very limited in what the[y] define as 'emergency.' Continuing emergency is not even contemplated." (Emphasis in original)

   A copy of the internal DEP memorandum on which Rocque wrote such statement in his own handwriting is attached hereto;

7. In September 1999, NNECO pleaded guilty in the U.S. District Court for the District of Connecticut to committing environmental felonies in violation of the terms and conditions of the said NPDES permit number CT0003253;

8. Dominion, through its corporate-related entities, recently settled an environmental lawsuit brought by the U.S. Department of Justice and the U.S. Environmental Protection Agency for violations of the Clean Air Act for $1.2 billion;

9. On or about March 11, 2005, the Conservation Law Foundation announced its intent to sue Dominion's corporate related entities for alleged illegal discharges of mercury into the

environment;

10. In consideration of these and other illegal activities carried out by NNECO at Millstone and by Dominion's corporate related entities at Millstone and elsewhere, Connecticut DEP lacks legal authority to renew the NPDES permit;

11. Dominion routinely discharges radioactive and toxic chemical and metal discharges into the Long Island Sound through its Millstone operations and it has done so continuously since on or about April 1, 2001 to the present;

12. Dominion routinely discharges some or all of the following radionuclides, chemicals and metals into the Long Island Sound, all in knowing and continuing violation of the CWA:

Ag
Be-7
Ce-144
Co-57
Co-58
Co-60
Cr-51
Cs-134
Cs-137
Fe-55
Fe-59
I-131
I-133
Kr-85
Kr-88
La-140
Mn-54
Mo-99
Na-24
Nb-95
Nb-97
Ru-105

4

Sb-122
Sb-124
Sb-125
Sn-113
Sr-89
Sr-90
Sr-92
TC-99M
TC-101
TC-104
Tritium
Xe-133
Xe-135
Zn-69M
Zr-95
Zr-97
Aluminum
Antimony
Ammonia
Ammonium Hydroxide
Arsenic
Barium
Beryllium
Boric Acid
Boron
Bromide
Bulab 6002
Cadmium
Carbohydrazide
Chlorine
Chromium
Cobalt
Conquor 3585 (methoxypropylamine and diethylhydroxylamine)
Copper
Cyanide
Dietylhydroxylamine
Epichlorohydrin
Ethanolomine
Fluoride
Freon

5

Hexavalent Chromium
Hydrazine
Hydrogen Peroxide
Iron
Methoxypropylamine
Molybdate
Molybdenum
Nalcolyte
Nickel
Nitrogen
Oil & Grease
Phosphorus
Selenium
Silver
Styrene
Sulfate
Sulfide
Sulfite
Surfactants
Thallium
Tin
Titanium
Tolyltriazole
Xylene
Zinc
Zirconium
Acrolein
Acrylonitrile
Benzene
Bromoform
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
2-Chloroethylvinyl Ether
Chloroform
Dichlorobromomethane
1, 1-Dichloroethane
1, 2-Dichloroethane
1, 1-Dichloroethylene

1, 2-Dichloropropane
1, 3-Dichloropropylene
Ethylbenzene
Methylbromide
Methylchloride
Methylene Chloride
1, 1, 2, 2, -Tetrachloroethane
Tetrachloroethylene
Toluene
1, 2-Trans-Dichloroethylene
1, 1, 1-Trichloroethane
1, 1, 2-Trichloroethane
Trichloroethylene
Vinyl Chloride
2-Chlorophenol
2, 4-Dichlorophenol
2, 4-Dimethylphenol
4, 6-Dinitro-O-Cresol
2, 4-Dinitrophenol
2-Nitrophenol
4-Nitrophenol
P-Chloro-M-Cresol
Pentachlorophenol
Phenol
2, 4, 6-Trichlorophenol
Acenaothylene
Benzidine
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(ghi)perylene
Benzo(k)fluoranthene
Bis(2-Chloroethyl) Ether
Bis(2-Ethylhexyl)phthalate
Chrysene
Dibenzo(ah)anthracene
1,2-Dichlorobenzene
1.3-Dichlorobenzene
1.4-Dichlorobenzene
3.3-Dichlorobenzidines
Diethyl phthalate

7

Dimethyl phthalate
Di-n-butyl phthalate
2,4-Dinitrotoulene
1,2-Diphenylhydrazine
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorocyclopentadiene
Hexachloroethane
Indenol1,2,3-ed)pyrene
Isophorone
Nurobenzene
N-Nitrosodimethylamine
N-Nitrosodiphenylamine
Phenanthrene
Pyrene
Aldrin
Chlordane
DDT
DDE
Dieldrin
Endosulfan(alpha)
Endosulfan (beta)
Endosulfan Sulfae
Endrin
Endrin Aldehyde
Heptachlor
Heotachlor epoxide
Arochlor 1016(PCB)
Arochlor 1232(PCB)
Arochlor 1242(PCB)
Arochlor 1248 (PCB)
Arochlor 1254 (PCB)
Arochlor 1260 (PCB)
Toxaphene
Ammonia
Benzo(b)fluoranthene
Chlorine
Hexachlorocyclohexane (Alpha)
Hexachlorocyclohexane (Beta)

8

Hexachlorocyclohexane (Gamma)
2,3,7,8-TCDD

13. The conduct described herein may involve knowing and deliberate violation of federal law by Dominion, NNECO and DEP.

MPS-83-3 The Coalition believes that the Millstone discharges as described above are causing grave and irreparable harm to the marine environment and to human health and that such conduct imperils the health and safety of its membership.

MPS-83-4 The Coalition further represents that some or all of the discharges to the Long Island Sound as listed hereinabove are unnecessary; if the Millstone Nuclear Power Station were to convert from a "once-through" to a "closed" cooling system, some or all of these harmful discharges to the Long Island Sound would be eliminated.

MPS-83-5 The Millstone discharges as described above are believed to be directly associated with the rare jawbone cancer found in Zachary M. Hartley at his birth on December 16, 1997. The Millstone discharges as described above are believed to be directly associated with a high and increasing incidence of cancer and related diseases among the human population that resides near the Millstone Nuclear Power Station and utilizes the surrounding beaches at Niantic Bay and Jordan Cove, if not beyond.

The Coalition hereby places Dominion on notice of its grounds for initiation of legal action pursuant to the Clean Water Act. The Coalition reserves its rights to include any additional violations in the forthcoming complaint. If you have any questions or wish to discuss this matter with us, please do not hesitate to contact us.

Very truly yours,

Nancy Burton

Please reply to:
Nancy Burton
147 Cross Highway

Redding Ridge CT 06876
Tel. 203-938-3952

cc:

Northeast Nuclear Energy Company
Northeast Utilities Service Company
Connecticut Light & Power Company
P.O. Box 270
Hartford CT 06141-0270

Attorney General
Department of Justice
10th Street and Constitution Avenue NW
Washington DC 20530

Environmental Protection Agency
1200 Pennsylvania Avenue NW
Washington DC 20460

Regional Administrator
Environmental Protection Agency
1 Congress Street
Suite 1100 (RAA)
Boston MA 02114-2023

Hon. Gina McCarthy
Commissioner
Department of Environmental Protection
79 Elm Street
Hartford CT 06106

Appendix B

Contributors to the Supplement

Appendix B

Contributors to the Supplement

The overall responsibility for the preparation of this supplement was assigned to the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (NRC). The statement was prepared by members of the Office of Nuclear Reactor Regulation with assistance from other NRC organizations, the Los Alamos National Laboratory, and the Pacific Northwest National Laboratory.

Name	Affiliation	Function or Expertise
	NUCLEAR REGULATORY COMMISSION	
Richard Emch, Jr.	Nuclear Reactor Regulation	Project Manager
Leslie Fields	Nuclear Reactor Regulation	Backup Project Manager
John Tappert	Nuclear Reactor Regulation	Section Chief
Andrew Kugler	Nuclear Reactor Regulation	Section Chief
Barry Zalcman	Nuclear Reactor Regulation	Program Manager
Michael T. Masnik	Nuclear Reactor Regulation	Ecology
James Wilson	Nuclear Reactor Regulation	Ecology
Jennifer Davis	Nuclear Reactor Regulation	Project Support
Stacey Imboden	Nuclear Reactor Regulation	Project Support
Harriet Nash	Nuclear Reactor Regulation	Project Support
Meghan Thorpe-Kavanaugh	Nuclear Reactor Regulation	Project Support
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Name	Affiliation	Function or Expertise
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Kim Green		Severe Accident Mitigation Alternatives
Bob Schmidt		Severe Accident Mitigation Alternatives

(a) Los Alamos National Laboratory is operated for the U.S. Department of Energy by the University of California.
(b) Pacific Northwest National Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute.

Appendix C

Chronology of NRC Staff Environmental Review Correspondence Related to Dominion Nuclear Connecticut, Inc.'s Applications for License Renewal of Millstone Power Station, Units 2 and 3

Appendix C

Chronology of NRC Staff Environmental Review Correspondence Related to Dominion Nuclear Connecticut, Inc.'s Applications for License Renewal of Millstone Power Station, Units 2 and 3

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and Dominion Nuclear Connecticut, Inc. (DNC) and other correspondence related to the NRC staff's environmental review, under 10 CFR Part 51, of DNC's applications for renewal of the Millstone Power Station (Millstone), Units 2 and 3, operating licenses. All documents, with the exception of those containing proprietary information, have been placed in the Commission's Public Document Room, at One White Flint North, 11555 Rockville Pike (first floor), Rockville, MD, and are available electronically from the Public Electronic Reading Room found on the Internet at the following Web address: <http://www.nrc.gov/reading-rm.html>. From this site, the public can gain access to the NRC's Agencywide Documents Access and Management System (ADAMS), which provides text and image files of NRC's public documents in the publicly available records component of ADAMS. The ADAMS accession number for each document is included below.

January 20, 2004 — Letter from Mr. David A. Christian, DNC, to NRC submitting the applications for the renewal of the operating licenses for Millstone Power Station, Units 2 and 3 (Accession No. ML040260070).

January 23, 2004 — NRC Press Release No. 04-011 "NRC Makes License Renewal Application Available for the Millstone Nuclear Power Plant" (Accession No. ML040230280).

January 28, 2004 — NRC staff letter to Mr. David A. Christian regarding the receipt and availability of the license renewal applications for Millstone Power Station, Units 2 and 3 (Accession No. ML040280258).

February 5, 2004 — NRC staff letter to Ms. Mildred Hodge, Library Director, Thames River Campus, Norwich, Connecticut, regarding the maintenance of reference material for public access related to the Millstone Power Station license renewal environmental review (Accession No. ML040400181).

February 5, 2004	NRC staff letter to Ms. Judy Liskov, Assistant Director, Waterford Public Library, Waterford, Connecticut, regarding the maintenance of reference material for public access related to the Millstone Power Station license renewal environmental review (Accession No. ML040400209).
February 6, 2004	NRC Press Release No. 04-002 "NRC to Hold Public Meeting in Connecticut on License Renewal Application for Millstone 2 and 3" (Accession No. ML040370209).
March 8, 2004	NRC staff letter to Mr. David A. Christian regarding the determination of acceptability and sufficiency for docketing, proposed review schedule, and opportunity for hearing regarding the license renewal applications for Millstone Power Station, Units 2 and 3 (Accession No. ML040680968).
March 17, 2004	NRC staff letter to Ms. Patricia A. Kurkul, Regional Administrator, National Marine Fisheries Service (NOAA Fisheries), Request for List of Protected Species Within the Area Under Evaluation for the Millstone Power Station, Units 2 and 3, License Renewal (Accession No. ML040770760).
March 18, 2004	NRC staff letter to Mr. Marvin Moriarty, Regional Director, U.S. Fish and Wildlife Service, Request for List of Protected Species Within the Area Under Evaluation for the Millstone Power Station, Units 2 and 3, License Renewal (Accession No. ML040780653).
March 25, 2004	Memo from Mr. Richard Gallagher, Dominion, regarding telecommunication on March 22, 2004 to NRC requests for Documents which Pertain to the Study of the Winter Flounder Population in the area around Millstone (Accession No. ML040930048).
March 29, 2004	Memo from Mr. Richard Gallagher, Dominion, regarding telecommunication on March 22, 2004 to NRC requests for Documents Pertaining to the Study of the Winter Flounder Population in the area around Millstone (Accession No. ML040930259).
March 30, 2004	NRC staff letter to Mr. Paul Loether, Director, Connecticut Historical Commission, regarding Millstone Power Station, Units 2 and 3, License Renewal Review (Accession No. ML040900503).

March 31, 2004	NRC staff letter to Mr. David A. Christian, Senior Vice President and Chief Nuclear Officer, DNC, Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process for License Renewal for the Millstone Power Station, Units 2 and 3 (Accession No. ML040920231).
April 8, 2004	NRC staff letter to Mr. Dona Klima, Director, Office of Federal Agency Programs, Advisory Council on Historic Preservation, Regarding Millstone Power Station, Units 2 and 3, License Renewal Review (Accession No. ML041000158).
April 12, 2004	Notice of Public Meeting to Discuss Environmental Scoping Process for Millstone Power Station, Units 2 and 3, License Renewal Application (Accession No. ML041050788).
April 14, 2004	NRC staff letter to the Honorable Matthew Thomas, Chief Sachem, Narragansett Indian Tribe, Request for Comments Concerning Millstone Power Station, Units 2 and 3, Operating License Renewal (Accession No. ML041050878).
April 14, 2004	NRC staff letter to the Honorable Michael J. Thomas, Chairman, Mashantucket Pequot Tribal Nation, Request for Comments Concerning Millstone Power Station, Units 2 and 3, Operating License Renewal (Accession No. ML041050880).
April 15, 2004	Letter from Mr. Michael J. Amaral, U.S. Fish and Wildlife Service, providing a response to the March 18, 2004, NRC staff letter requesting information regarding threatened and endangered species in the vicinity of the Millstone Power Station, Units 2 and 3 (Accession No. ML041190230).
April 16, 2004	Memo from Mr. Richard Gallagher, DNC to NRC, regarding email on April 15, 2004, requesting documents pertaining to the study of the winter flounder population in the area around Millstone (Accession No. ML041120271).
April 19, 2004	Email to Mr. Ted B. Doerr from NRC, providing comments regarding the Site Audit Needs (Accession No. ML041240396).

April 26, 2004	Email to Mr. Richard Gallagher from NRC, regarding questions and comments on the List of Onsite Data Needs (Accession No. ML041240402).
April 27, 2004	Letter from Mr. Charles H. Evans, Director, Connecticut Department of Environmental Protection, Office of Long Island Sound Programs to NRC and Dominion regarding coastal zone consistency concurrence (Accession No. ML041320497).
April 29, 2004	Email from Richard Gallagher, Dominion, to NRC, requesting additional information regarding severe accident mitigation alternatives review for Millstone (Accession No. ML041240405).
May 11, 2004	NRC Press Release No. 04-030 "NRC Seeks Public Input On Environmental Impact Statement For Proposed Millstone Nuclear Plant License Renewal" (Accession No. ML041320568).
May 18, 2004	NRC Public Meeting Feedback Form "Public Scoping Meetings to Discuss Environmental Issues Pertaining to the Application for License Renewal of Millstone Power Station, Units 2 and 3" (Accession No. ML041700578).
May 24, 2004	Note to file regarding the docketing of additional documents pertaining to winter flounder in support of the environmental review of Millstone Power Station, Units 2 and 3 license renewal application (Accession No. ML041460138).
May 24, 2004	Note to file regarding the docketing of additional documents pertaining to winter flounder in support of the environmental review of Millstone Power Station, Units 2 and 3 license renewal application (Accession No. ML041460283).
May 24, 2004	Note to file regarding the docketing of emails sent to DNC in support of the environmental review of Millstone Power Station, Units 2 and 3 license renewal application (Accession No. ML041460250).
May 24, 2004	Comment letter from the Honorable Fred W. Thiele, Jr., Assemblyman, regarding the environmental review of Millstone Power Station, Units 2 and 3 license renewal application (Accession No. ML041620373).

June 1, 2004	Note to file regarding the docketing of documents pertaining to winter flounder in support of the environmental review of Millstone Power Station, Units 2 and 3 license renewal application (Accession No. ML041560169).
June 1, 2004	Email from Mr. Charles D. Stephani providing scoping comments regarding Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML041770290).
June 2, 2004	Email from Hortense and Ralph Carpenter providing scoping comments regarding Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML041770288).
June 3, 2004	Email from Kelly L. Streich providing scoping comments regarding Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML041770177).
June 4, 2004	Email from Mr. Douglas Schwartz providing scoping comments regarding Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML041770175).
June 4, 2004	Letter from Ms. Nancy Burton, Esq., to NRC staff regarding the Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML041770182).
June 22, 2004	NRC staff letter to Mr. David A. Christian, DNC, forwarding request for additional information regarding severe accident mitigation alternatives for the Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML041740175).
June 24, 2004	Summary of Public Scoping Meetings to Support Review to support the review of Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML041830272).
July 27, 2004	NRC letter to DNC forwarding the summary of site audit to support the review of Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML042100293).
July 28, 2004	Letter from First Selectman Paul B. Eccard, Town of Waterford, to NRC regarding Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML042160111).

August 13, 2004	Letter from Leslie N. Hartz, DNC, to NRD forwarding response to request for additional information regarding Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML042320613).
August 17, 2004	NRC staff letter to Mr. Paul B. Eccard, acknowledging receipt of comments regarding Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML042320342).
August 27, 2004	NRC staff letter to Mr. David A. Christian, DNC, forwarding the environmental scoping summary report associated with the staff's review of Millstone Power Station, Units 2 and 3 applications (Accession No. ML042400543).
September 16, 2004	Email correspondence between NRC staff and DNC regarding the SAMA review for Millstone Power Station, Units 2 and 3 applications (Accession No. ML042710222).
September 21, 2004	Letter from Ms. Mary A. Colligan, NOAA Fisheries, to P.T. Kuo, NRC, providing a response to the March 18, 2004, NRC staff letter requesting information regarding threatened and endangered species in the vicinity of the Millstone Power Station, Units 2 and 3 (Accession No. ML042810294).
September 24, 2004	Summary of telephone conference conducted with the Town of Waterford regarding Millstone Power Station, Units 2 and 3 applications (Accession No. ML042710257).
September 24, 2004	Summary of telephone conference regarding the SAMA review of Millstone Power Station, Units 2 and 3 applications (Accession No. ML042710529).
October 6, 2004	Letter from Mr J. Paul Loether, Connecticut State Historic Preservation Officer, to P.T. Kuo, NRC, providing comments regarding Millstone Power Station, Units 2 and 3 License Renewal Application effect on historic properties (Accession No. ML042880497).

October 6, 2004	Letter from First Selectman Paul B. Eccard, Town of Waterford, to Richard L. Emch, Jr., NRC, response to September 24, 2004, letter from NRC regarding Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML043210191).
October 25, 2004	Note to File from Richard L. Emch, Jr., NRC. Subject: Summary of Telephone Conference Regarding SAMA Analyses Conducted on October 7, 2004, with Dominion Connecticut Nuclear, Inc. In Support of the Environmental Review of the License Renewal Application for Millstone Power Station Units 2 and 3. (Accession No. ML043000449).
October 29, 2004	Note to File from Richard L. Emch, Jr., NRC. Subject: Correction of Summary Dated September 24, 2004, of Telephone Conference Regarding SAMA Analyses Conducted on September 13, 2004, with Dominion Connecticut Nuclear, Inc. in Support of the Environmental Review of the License Renewal Application for Millstone Power Station Units 2 and 3. (Accession No. ML 043030362).
November 9, 2004	NRC staff letter to Ms. Patricia A. Kurkul, Regional Administrator, NOAA Fisheries, Request for Concurrence - Biological Assessment for Millstone Power Station, Units 2 and 3 (Accession No. ML043170594).
November 9, 2004	NRC staff letter to Mr. Marvin Moriarty, Regional Director, U.S. Fish and Wildlife Service, Request for Concurrence - Biological Assessment for Millstone Power Station, Units 2 and 3 (Accession No. ML043170643).
December 2, 2004	NRC staff letter to U.S. Environmental Protection Agency, Filing of Draft Supplement 22 to NUREG-1437 (Accession No. ML043370472).
December 2, 2004	NRC staff letter to Mr. David A. Christian, Senior Vice President and Chief Nuclear Officer, Dominion Nuclear Connecticut, Inc., Notice of Availability of Draft Supplement 22 to NUREG-1437 (Accession No. ML043370478).
December 9, 2004	NRC press release announcing the public meeting regarding the Draft Supplement 22 to NUREG-1437 (Accession No. ML043440093).
December 20, 2004	NRC memorandum regarding the public meeting for the Draft Supplement 22 to NUREG-1437, including the meeting agenda and notice (Accession No. ML043560137).

January 5, 2005	Letter from Mr. Michael J. Amaral, Endangered Species Specialist, U.S. Fish and Wildlife Service, to Mr. P.T. Kuo, NRC, Concurrence and consultation closure (Accession No. ML050210354).
January 11, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, requesting copies of RAIs and RAI responses (Accession No. ML051330301).
January 12, 2005	Letter from Ms. Patricia A. Kurkul, Regional Administrator, NOAA Fisheries, to P.T. Kuo, NRC, Millstone Power Station, Units 2 and 3 license renewal (Accession No. ML051021054).
January 23, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, submitting a FOIA request (Accession No. ML051330300).
January 31, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding FOIA response schedule (Accession No. ML051330298).
February 2, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding questions about the DSEIS (Accession No. ML051330296).
February 2, 2005	NRC staff letter to Mr. Joshua Y. Horton, Supervisor, Southold Town, response regarding Millstone Power Station, Units 2 and 3 license renewal review (Accession No. ML050340609).
February 4, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding questions about the DSEIS (Accession No. ML051330292).
February 8, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding questions about the DSEIS (Accession No. ML051330285).
February 10, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding questions about the DSEIS (Accession No. ML051330297).
February 10, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding questions about the DSEIS (Accession No. ML051330293).
February 15, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding questions about the DSEIS (Accession No. ML051330290).
February 18, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding the schedule for meeting transcripts (Accession No. ML051330286).

February 18, 2005	Email from R. Emch, NRC, to Ms. Nancy Burton including attached transcripts from the public meeting (Accession No. ML051330034).
February 21, 2005	Email from Ms. Nancy Burton to A. Kugler, NRC, regarding questions about the DSEIS (Accession No. ML051330352).
February 23, 2005	Email from R. Emch, NRC, to Ms. Nancy Burton regarding questions about the DSEIS (Accession No. ML051330072).
February 23, 2005	Email from R. Emch, NRC, to Ms. Nancy Burton regarding questions about the DSEIS (Accession No. ML051330077).
February 24, 2005	Email from Ms. Nancy Burton to A. Kugler, NRC, regarding questions about the DSEIS (Accession No. ML051330349).
February 24, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding questions about the DSEIS (Accession No. ML051330141).
February 24, 2005	Email from A. Kugler, NRC, to Ms. Nancy Burton regarding questions about the DSEIS (Accession No. ML051470090).
February 24, 2005	Email from R. Emch, NRC, to Ms. Nancy Burton regarding questions about the DSEIS (Accession No. ML051330083).
February 24, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding questions about the DSEIS (Accession No. ML051330138).
February 25, 2005	Summary of the public meeting for the Draft Supplement 22 to NUREG-1437 (Accession No. ML050610357).
February 28, 2005	Email from Ms. Nancy Burton to A. Kugler, NRC, requesting extension of the comment period (Accession No. ML051330135).
February 28, 2005	Email from Ms. Nancy Burton to the NRC Commissioners requesting extension of the comment period (Accession No. ML050670486).
February 28, 2005	Email from R. Emch, NRC, to Ms. Nancy Burton regarding request for extension of the comment period (Accession No. ML051330040).
March 9, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding questions about the DSEIS (Accession No. ML051330132).

March 9, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, inviting the NRC to a press conference (Accession No. ML051330126).
March 9, 2005	Email from R. Emch, NRC, to Ms. Nancy Burton regarding her FOIA request (Accession No. ML051330143).
March 10, 2005	Email from A. Kugler, NRC, to Ms. Nancy Burton declining her invitation to the press conference (Accession No. ML05133032).
March 11, 2005	Email from Ms. Nancy Burton to A. Kugler, NRC, sending a news article about Millstone (Accession No. ML051330118).
March 11, 2005	Email from Ms. Nancy Burton to A. Kugler, NRC, sending a news article about Millstone (Accession No. ML051330115).
March 11, 2005	Email from Ms. Nancy Burton to A. Kugler, NRC, sending a news article about Millstone (Accession No. ML051330110).
March 12, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding comments on the DSEIS (Accession No. ML051330097).
March 13, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, requesting a cited reference from the NRC (Accession No. ML051330095).
March 14, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding comments about the DSEIS (Accession No. ML051330088).
March 15, 2005	Email from R. Emch, NRC, to Ms. Nancy Burton regarding questions about the DSEIS (Accession No. ML051330050).
March 16, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, indicating that her supplemental comments are attached (Accession No. ML051330082).
March 16, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, including the supplemental comments that were not attached to previous email (Accession No. ML051330078). [Ms. Burton submitted a corrected version of these comments on March 22, 2005, by email; the corrected version is included in Appendix A.]

March 21, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, notifying the NRC of the Connecticut Coalition Against Millstone's intent to sue Dominion (Accession No. ML051330092).
March 27, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, requesting information about NRC's offsite visits (Accession No. ML051330075).
March 28, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding questions about the DSEIS (Accession No. ML051330079).
March 28, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, requesting a document (Accession No. ML051330089).
March 28, 2005	Email from Ms. Nancy Burton to Commissioner McCarthy, Connecticut Department of Environmental Protection, regarding the coastal zone management consistency review (Accession No. ML051330100).
March 28, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding comments on the DSEIS (Accession No. ML051330103).
March 28, 2005	Email from R. Emch, NRC, to Ms. Nancy Burton regarding closure of the comment period (Accession No. ML051330063).
March 28, 2005	Email from R. Emch, NRC, to Ms. Nancy Burton sending her a requested document (Accession No. ML051330057).
March 30, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, with her attached letter to the editor sent to The New London Day (Accession No. ML051330107).
March 30, 2005	Email from R. Emch, NRC, to Ms. Nancy Burton regarding the closure of the comment period (Accession No. ML051330090).
March 30, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, regarding comments on the DSEIS (Accession No. ML051330113).
March 30, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, submitting a press release about Millstone (Accession No. ML051330119).

April 8, 2005	Email from Ms. Nancy Burton to C. Santos, NRC, notifying the Advisory Committee on Reactor Safeguards of documents submitted to the NRC (Accession No. ML051330125).
April 14, 2005	Email from Ms. Nancy Burton to R. Emch, NRC, providing copy of letter from Ms. Burton to Donald W. Downes, Connecticut Department of Public Utility (Accession No. ML051330137).
May 17, 2005	Note to file from R. Emch summarizing telephone conference with EPA, Region 1, on April 5, 2005 (Accession No. ML051380272).
May 17, 2005	Note to file from R. Emch summarizing telephone discussion with representative of Connecticut Tumor Registry on April 8, 2005 (Accession No. ML051380488).

Appendix D

Organizations Contacted

Appendix D

Organizations Contacted

During the course of the staff's independent review of environmental impacts from operations during the renewal term, the following Federal, State, regional, local, and Native American tribal agencies were contacted:

Chamber of Commerce of Eastern Connecticut, Inc., Gales Ferry, CT

Connecticut Commercial Realty, New London, CT

Connecticut Department of Environmental Protection, Bureau of Air Management, Division of Radiation, Hartford, CT

Connecticut Department of Environmental Protection, Bureau of Waste Management, Hartford, CT

Connecticut Department of Environmental Protection, Bureau of Water Management, Hartford, CT

Connecticut Department of Environmental Protection, Marine Fisheries Division, Old Lyme, CT

Connecticut Department of Environmental Protection, Office of Long Island Sound Programs, Hartford, CT

Connecticut Department of Public Health, Connecticut Tumor Registry, Hartford, CT

Connecticut Historical Commission, Hartford, CT

National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, Milford, CT

Southeastern Connecticut Council of Governments, Norwich, CT

Southeastern Connecticut Enterprise Region, New London, CT

Town of Waterford, CT

U.S. Environmental Protection Agency, Region 1, Boston, MA.

Appendix D

U.S. Geological Survey, Woods Hole, MA

United Way of Southeastern Connecticut, Gales Ferry, CT

University of Connecticut, Department of Physiology and Neurobiology, Storrs, CT

Waterford Public Schools, Waterford, CT

Appendix E

Millstone Compliance Status and Consultation Correspondence

Appendix E

Millstone Compliance Status and Consultation Correspondence

Correspondence received during the process of evaluation of the application for renewal of the operating licenses for Millstone Power Station Units 2 and 3 (Millstone) are identified in Table E-1. Copies of the correspondence are included at the end of this appendix.

The licenses, permits, consultations, and other approvals obtained from Federal, State, regional, and local authorities for Millstone are listed in Table E-2.

Table E-1. Consultation Correspondence

Source	Recipient	Date of Letter
U.S. Nuclear Regulatory Commission (P. T. Kuo)	NOAA Fisheries (P. A. Kurkul)	March 17, 2004
U.S. Nuclear Regulatory Commission (P. T. Kuo)	U.S. Fish and Wildlife Service (M. Moriarty)	March 18, 2004
U.S. Nuclear Regulatory Commission (P. T. Kuo)	Connecticut Historical Commission (Paul Loether)	March 30. 2004
U.S. Nuclear Regulatory Commission (P. T. Kuo)	Advisory Council on Historic Preservation (D. Klima)	April 8, 2004
U.S. Nuclear Regulatory Commission (P. T. Kuo)	Narragansett Indian Tribe (M. Thomas, Chief Sachem)	April 14, 2004
U.S. Nuclear Regulatory Commission (P. T. Kuo)	Mashantucket Pequot Tribal Nation (M. J. Thomas)	April 14, 2004
U.S. Fish and Wildlife Service (M. J. Amaral)	U.S. Nuclear Regulatory Commission (P. T. Kuo)	April 15, 2004
Connecticut Department of Environmental Protection (C. H. Evans)	U.S. Nuclear Regulatory Commission (R. Emch)	April 27, 2004
NOAA Fisheries (M. A. Colligan)	U.S. Nuclear Regulatory Commission (P.T. Kuo)	September 21, 2004

Table E-1. Consultation Correspondence (contd.)

Source	Recipient	Date of Letter
State of Connecticut Commission on Culture and Tourism (J. Paul Loether)	U.S. Nuclear Regulatory Commission (P. T. Kuo)	October 6, 2004
U.S. Nuclear Regulatory Commission (P. T. Kuo)	NOAA Fisheries (P. A. Kurkul)	November 9, 2004
U.S. Nuclear Regulatory Commission (P. T. Kuo)	U.S. Fish and Wildlife Service (M. Moriarty)	November 9, 2004
U.S. Fish and Wildlife Service (M. Amaral)	U.S. Nuclear Regulatory Commission (P. T. Kuo)	January 5, 2005
NOAA Fisheries (P. Kurkul)	U.S. Nuclear Regulatory Commission (P. T. Kuo)	January 12, 2005

Table E-2. Federal, State, Local, and Regional Licenses, Permits, Consultations, and Other Approvals for Millstone

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
NRC	10 CFR Part 50	Operating license, Millstone Unit 2	DPR-65	09/26/75	07/31/15	Authorizes operation of Unit 2.
NRC	10 CFR Part 50	Operating license, Millstone Unit 3	NPF-49	01/31/86	11/25/25	Authorizes operation of Unit 3.
USACE	Section 10, River and Harbor Act (33 USC 403)	Permit	CT-NIAN-78-507	10/11/78	No expiration date	Install and maintain sandbag dike for ecology laboratory mariculture work.
USACE	Section 10, River and Harbor Act (33 USC 403)	Permit	CT-NIAN-77-377 (LOP)	09/19/77	No expiration date	Install and maintain ecology laboratory seawater intake pipes.
USDOT	49 USC 5108	Registration	061202550034KL	06/13/02	06/30/04	Shipment of hazardous materials.
FWS	Migratory Bird Treaty Act (16 USC 703-712)	Depredation Permit	MB728673-0	06/07/03	06/30/04	Removal of birds, eggs and nests from utility structures and property.
FWS	Section 7 of the Endangered Species Act (16 USC 1536)	Consultation		01/05/05		Requires a Federal agency to consult with FWS regarding whether a proposed action would affect endangered or threatened species.
NMFS	Section 7 of the Endangered Species Act (16 USC 1536)	Consultation		01/12/05		Requires a Federal agency to consult with NOAA Fisheries regarding whether a proposed action would affect endangered or threatened species.

Table E-2. (contd.)

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
Connecticut Historical Commission	Section 106 of the National Historic Preservation Act (16 USC 470f)	Consultation				The National Historic Preservation Act requires Federal agencies to take into account the effect of any undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places.
Connecticut Department of Environmental Protection (CTDEP)	Section 307 of the Coastal Zone Management Act [16 USC 1456(c)(3)(A)]	Consistency determination with the Connecticut Coastal Management Program				The Connecticut Department of Environmental Protection waived the review to coordinate with the State NPDES permit review process.
CTDEP	CGS 4-182, 22a-430, 22a-430-1 et seq.	National Pollution Discharge Elimination System Permit	NPDES permit CT0003263	12/14/92		Renewal application submitted 6/13/97; plant discharges to Long Island Sound.
CTDEP	CGS 22a-430b	General Permit for stormwater discharges	GSI001430	09/25/03		Stormwater discharges; industrial activities.
CTDEP	CGS 22a-6K	Emergency Authorization	EA 0100176	10/13/00		Transferred 3/31/01: plant discharges to Long Island Sound.
CTDEP	CGS 22a-430	General Permit for Discharge of Minor Photographic Processing Wastewater	GPH000354	10/20/95	10/20/05	Discharge of minor photographic process wastewater to municipal sewer
CTDEP	CGS 22a-430	General Permit for the Discharge of Water Treatment Wastewater	GWT 000175	03/26/01	05/01/05	Water treatment wastewater.

Table E-2. (contd)

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
CTDEP	CGS 22a-430	General Permit for Miscellaneous Discharges of Sewer Compatible Wastewater	GMI000012	03/13/02	04/30/11	Wastewater discharges from Fire Training Facility.
CTDEP	Ct. P.A. 82-402, Section 4	Registration	2000-018-PWR-SU (Unit 2)	07/12/83		Transferred on 03/31/01; No expiration date; Divert large volume of water from Long Island Sound for steam condenser cooling water.
CTDEP	Ct. P.A. 82-402, Section 4	Registration	2000-019-PWR-SU (Unit 3)	07/12/83		Transferred on 03/31/01; No expiration date; Divert large volume of water from Long Island Sound for steam condenser cooling water.
CTDEP	CGS 22a-174	Permit	199-0003-0043	08/10/00		Emissions from fire training mock-up facility and two propane-fired water pumps.
CTDEP	CGS 22a-174	Permit	199-0003-0044	04/27/99		Emissions from diesel-fired trash water pump.
CTDEP	CGS 22a-174	Permit	199-0003-0045	04/27/99		Emissions from diesel-fired motorpool air compressor
CTDEP	CGS 22a-174	Permit	199-0003-0046	04/27/99		Operate diesel-fired motorpool air compressor.
CTDEP	CGS 22a-174	Permit	199-0004-0056	11/09/99		Emissions from Unit 2 emergency diesel generator (1 of 2).

Table E-2. (contd.)

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
CTDEP	CGS 22a-174	Permit	199-0003-0055	11/09/99		Emissions from Unit 2 emergency diesel generator (2 of 2).
CTDEP	CGS 22a-174	Permit	199-0003-0007	01/24/86		Emissions from Unit 3 auxiliary boiler (1 of 2).
CTDEP	CGS 22a-174	Permit	199-0003-0008	01/24/86		Emissions from Unit 3 auxiliary boiler (2 of 2).
CTDEP	CGS 22a-174	Permit	199-0003-0009	05/21/85		Emissions from Unit 3 emergency diesel generator (1 of 2).
CTDEP	CGS 22a-174	Permit	199-0003-0010	05/21/85		Emissions from Unit 3 emergency diesel generator (2 of 2).
CTDEP	CGS 22a-174	Permit	199-0003-0017	08/25/92		Emissions from station blackout emergency diesel generator (3 of 3)
CTDEP	CGS 22a-174	Permit	199-0003-0053	05/27/99		Emissions from Unit 3 ESF diesel compressor.
CTDEP	CGS 22a-449	Notification Site ID	170-8414	03/27/01		Unit 3 emergency generator underground storage tank E6, #2 diesel oil.
CTDEP	CGS 22a-449	Notification Site ID	170-8414	03/27/01		Unit 3 emergency generator underground storage tank E7, #2 diesel oil.
CTDEP	CGS 22a-449	Notification Site ID	170-8414	03/27/01		Unit 3 auxiliary boiler underground storage tank F8, #4 heating oil.
CTDEP	CGS 22a-449	Notification Site ID	170-8414	03/27/01		Unit 3 auxiliary boiler underground storage tank F9, #4 heating oil.

Table E-2. (contd.)

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
CTDEP	CGS 22a-449	Notification Site ID	170-8425	03/27/01		Simulator building underground storage tank, #2 heating oil.
CTDEP	CGS 22a-449	Notification Site ID	170-8486	03/27/01		Unit 2 emergency diesel underground storage tank, #2 fuel oil. This tank has been retired.
South Carolina Department of Health and Environmental Control	South Carolina Radioactive Waste Transportation and Disposal Act (Act No. 429 of 1980)	Permit	0013-06-04	12/10/03	12/31/04	Transport radioactive wastes.
Tennessee Department of Environment and Conservation	Rule 1200-2-10.32	License	T-CT003-L04	12/02/03	12/31/04	Ship radioactive materials.
CTDEP	CGS 26-60	Scientific Collector Permit	219	01/17/03	01/16/06	Collect fish and lobsters.
CTDEP	CGS Title 22a, Chapter 445	Permit (Part A application)	not applicable	12/22/00		Store radioactive hazardous (i.e., mixed) waste.
CTDEP	CGS 22a-174	Permit	199-0038-TV	01/29/03	01/29/08	Emissions (Title V permit).

CFR = Code of Federal Regulations
USACE = U.S. Army Corps of Engineers
USDOT = U.S. Department of Transportation
FWS = U.S. Fish and Wildlife Service
NRC = U.S. Nuclear Regulatory Commission
EPA = U.S. Environmental Protection Agency
NOAA = National Oceanic and Atmospheric Administration
USC = United States Code
CGS = Connecticut General Statutes
ESF = Engineered Safeguards Features

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 17, 2004

Patricia A. Kurkul, Regional Administrator
NOAA Fisheries
Northeast Regional Office
One Blackburn Drive
Gloucester, MA 09130-2298

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR MILLSTONE POWER STATION, UNITS 2 AND 3, LICENSE RENEWAL

Dear Ms. Kurkul:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by Dominion Nuclear Connecticut Inc. (DNC) for the renewal of the operating licenses for Millstone Power Station, Units 2 and 3 (MPS). MPS is located on the north shore of Long Island Sound in Waterford, Connecticut, approximately 40 miles southeast of Hartford, Connecticut. As part of the review of the license renewal application, the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of the National Environmental Policy Act (NEPA) of 1969, as amended, which include an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The MPS site covers approximately 525 acres, of which approximately 220 acres are industrial. The area surrounding MPS is characterized by old field, mesic hardwood forest, coastal marsh and beach habitats. DNC also maintains a 50-acre wildlife refuge in the eastern portion of the MPS site.

Each MPS unit uses a once-through open-cycle cooling system with intakes on Niantic Bay and surface discharges to an old quarry cut, which empties into Long Island Sound. Occasional dredging or de-mucking at the intakes is performed as a normal part of operation.

For the specific purpose of connecting MPS to the regional transmission system, there is a total of approximately 91 miles of transmission line corridors that occupy approximately 3,052 acres of land. These transmission line corridors are being evaluated as part of the SEIS process. The transmission line corridors traverse New London, Toland, Hartford, Middlesex, and New Haven Counties. The corridors pass through land that is primarily agricultural and forest land. The enclosed transmission line map shows the transmission system that is being evaluated in the SEIS. Four 345-kilovolt (kV) lines connect MPS to the electric grid. All four transmission lines run northward from the plant in a common corridor (415 to 500 feet wide) for 9.1 miles to Hunts Brook Junction. At Hunts Brook Junction, the lines diverge, with two lines running north

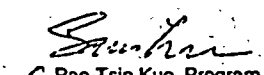
to the Card and Manchester Substations, one line running east to the Montville Station, and one line running west to the Southington Substation. These four lines share corridors with other previously existing transmission lines.

To support the EIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act of 1973, the NRC requests a list of endangered, threatened, candidate, and proposed species, and designated and proposed critical habitat under the jurisdiction of NOAA Fisheries, that may be in the vicinity of MPS site and its transmission line corridors. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act. The NRC has also contacted the Fish and Wildlife Service and requested a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of MPS and its associated transmission lines.

We plan to hold two public NEPA scoping meetings on May 18, 2004, at the Waterford Town Hall Auditorium, 15 Rope Ferry Road in Waterford, Connecticut. On May 19, 2004, we plan to conduct a site audit. You and your staff are invited to attend both the site audit and the public meetings. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is December 2004.

If you have any questions concerning the NRC staff review of this license renewal application, please contact Mr. Richard L. Emch, Jr., Senior Project Manager at 301-415-1590 or RLE@nrc.gov.

Sincerely,



Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-336 and 50-423

Enclosures: 1. MPS Transmission Line Map
2. MPS Site Layout

cc w/end.: See next page

Figure 3-2
Transmission Line Map

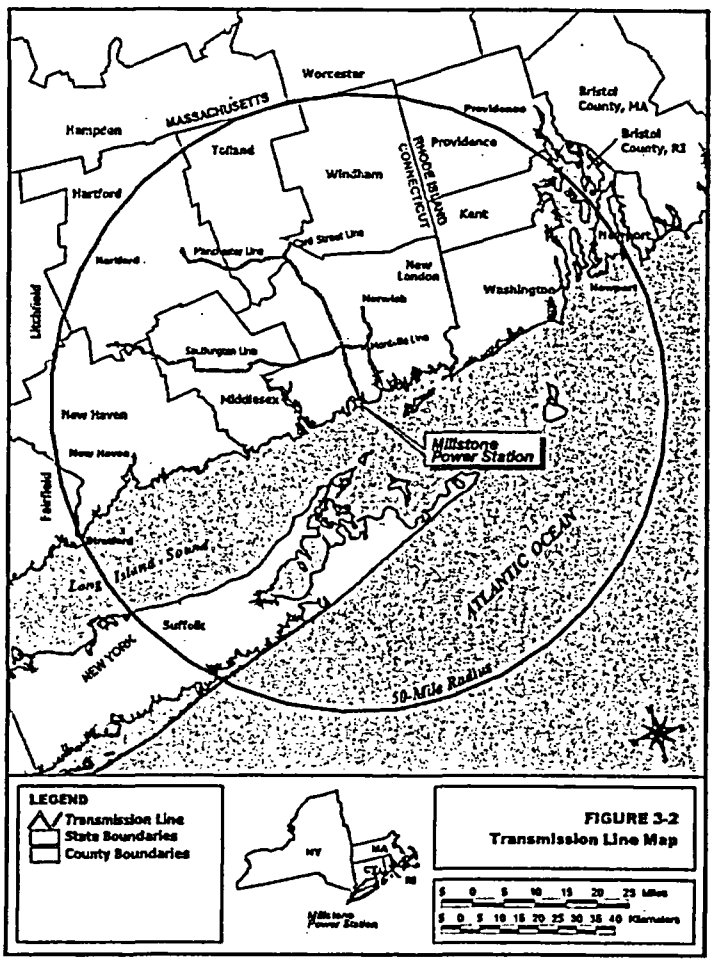
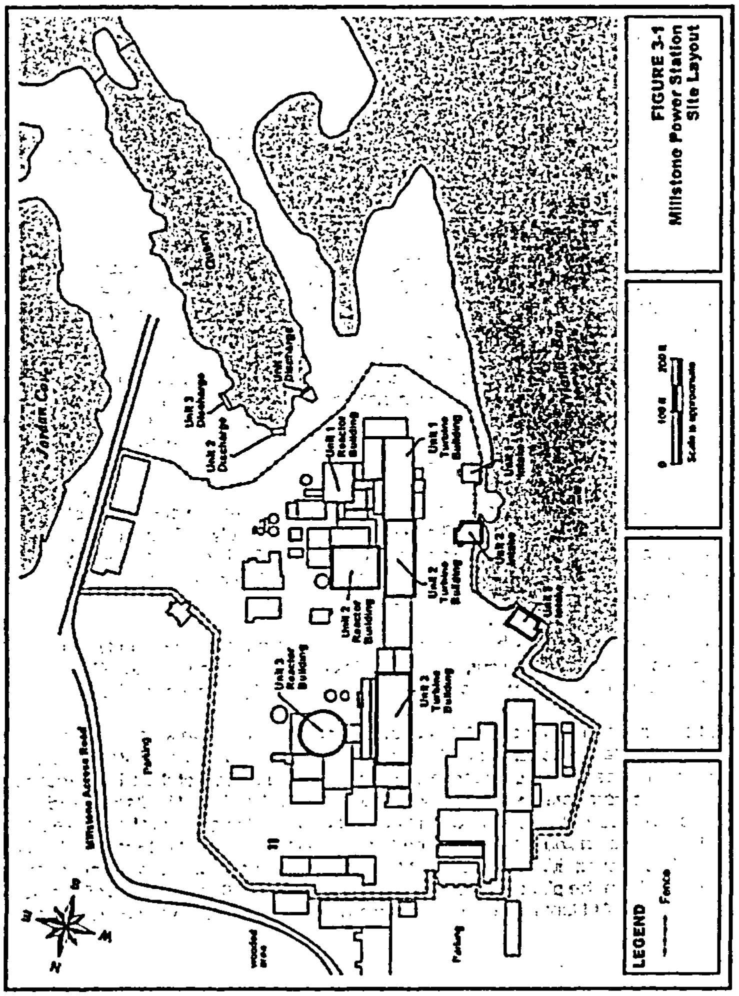


Figure 3-1
Millstone Power Station Site Layout



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 18, 2004

Marvin Moriarty, Regional Director
Northeast Regional Office
U.S. Fish and Wildlife Service
300 Westgate Center Drive
Hadley, MA 01035-9589

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE MILLSTONE POWER STATION, UNITS 2 AND 3 LICENSE RENEWAL

Dear Mr. Moriarty:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by Dominion Nuclear Connecticut Inc. (DNC) for the renewal of the operating licenses for Millstone Power Station, Units 2 and 3 (MPS). MPS is located on the north shore of Long Island Sound in Waterford, Connecticut, approximately 40 miles southeast of Hartford, Connecticut. As part of the review of the license renewal application, the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of the National Environmental Policy Act (NEPA) of 1969, as amended, which includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The MPS site covers approximately 525 acres, of which approximately 220 acres is industrial. The area surrounding MPS is characterized by old field, mesic hardwood forest, coastal marsh and beach habitats. DNC also maintains a 50-acre wildlife refuge in the eastern portion of the MPS site.

Each MPS unit uses a once-through open-cycle cooling system with intakes on Niantic Bay and surface discharges to an old quarry cut, which empties into Long Island Sound. Occasional dredging or de-mucking at the intakes is performed as a normal part of operation.

For the specific purpose of connecting MPS to the regional transmission system, there is a total of approximately 91 miles of transmission line corridors that occupy approximately 3,052 acres of land. These transmission line corridors are being evaluated as part of the SEIS process. The transmission line corridors traverse New London, Toland, Hartford, Middlesex, and New Haven Counties. The corridors pass through land that is primarily agricultural and forest land. The enclosed transmission line map shows the transmission system that is being evaluated in the SEIS. Four 345-kilovolt (kV) lines connect MPS to the electric grid. All four transmission lines run northward from the plant in a common corridor (415 to 500 feet wide) for 9.1 miles to Hunts Brook Junction. At Hunts Brook Junction, the lines diverge, with two lines running north

to the Card and Manchester Substations, one line running east to the Montville Station, and one line running west to the Southington Substation. These four lines share corridors with other previously existing transmission lines.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of MPS and its associated transmission lines. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act.

We plan to hold two public NEPA scoping meetings on May 18, 2004, at the Waterford Town Hall Auditorium, 15 Rope Ferry Road in Waterford, Connecticut. On May 19, 2004, we plan to conduct a site audit. You and your staff are invited to attend both the site audit and the public meetings. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is December 2004.

If you have any questions concerning the NRC staff review of this license renewal application, please contact Mr. Richard L. Emch, Jr., Senior Project Manager at 301-415-1590 or RLE@nrc.gov.

Sincerely,

/RA/

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-336, 50-423

Enclosures: 1. MPS Transmission Line Map
2. MPS Site Layout

cc w/encl.: See next page

Figure 3-2
Transmission Line Map

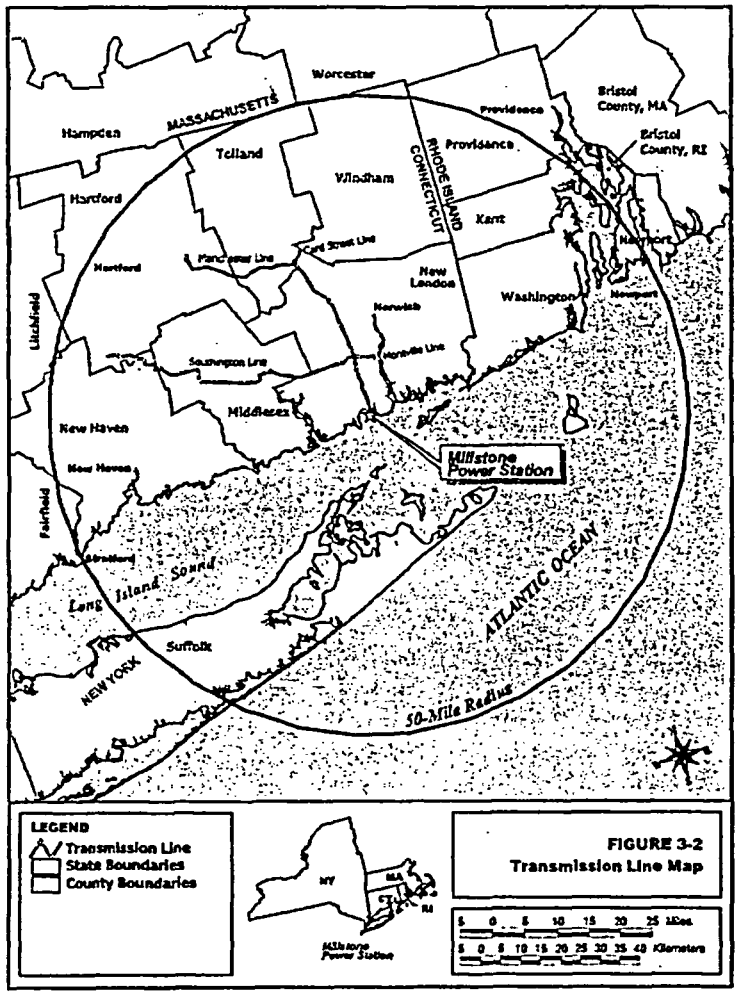
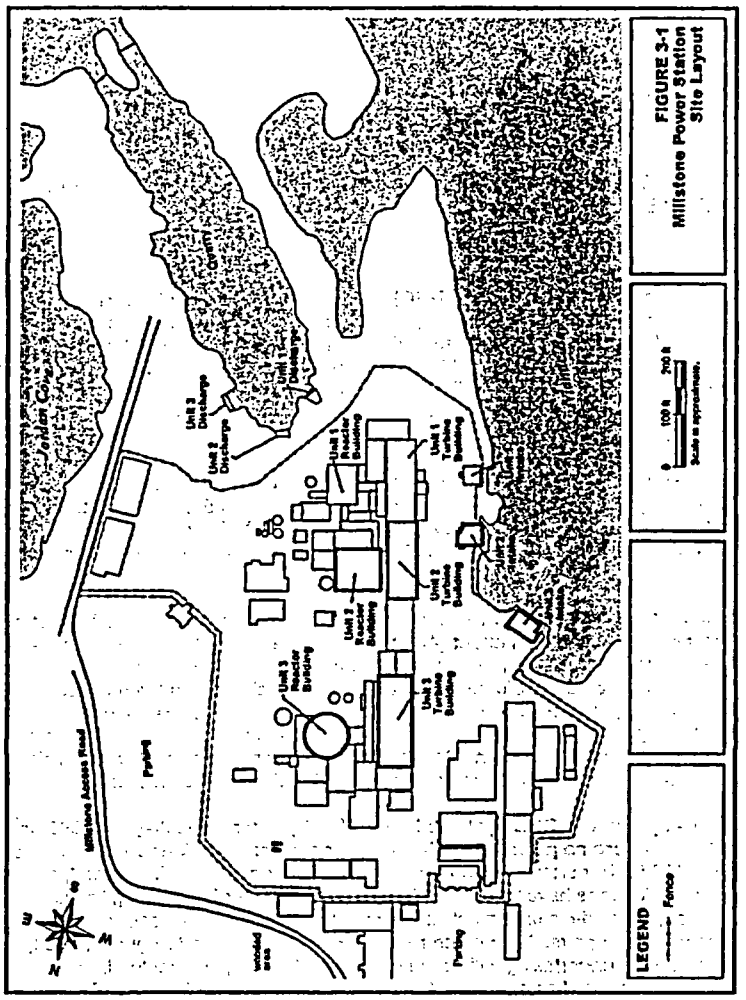


Figure 3-1
Millstone Power Station Site Layout



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 30, 2004

Mr. Paul Loether, Director
Connecticut Historical Commission
59 South Prospect Street
Hartford, CT 06106

SUBJECT: MILLSTONE POWER STATION, UNITS 2 AND 3 LICENSE RENEWAL REVIEW

Dear Mr. Loether:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application to renew the operating licenses for Millstone Power Station, Units 2 and 3 (MPS), which is located on the north shore of Long Island Sound in Waterford, Connecticut, approximately 40 miles southeast of Hartford, Connecticut. MPS is operated by Dominion Nuclear Connecticut Inc. (DNC). The application for renewal was submitted by DNC on January 22, 2004, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). The NRC has established that, as part of the staff review of any nuclear power plant license renewal action, a site-specific Supplemental Environmental Impact Statement (SEIS) to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437, will be prepared under the provisions of 10 CFR Part 51, the NRC rules that implement the National Environmental Policy Act of 1969 (NEPA). In accordance with 36 CFR 800.8, the SEIS will include analyses of potential impacts to historic and archaeological resources.

In the context of the National Historic Preservation Act of 1966, as amended, the NRC staff has determined that the area of potential effect (APE) for a license renewal action is the area at the power plant site and its immediate environs that may be impacted by post-license renewal land-disturbing operations or projected refurbishment activities associated with the proposed action. The APE may extend beyond the immediate environs in those instances where post-license renewal land-disturbing operations or projected refurbishment activities, specifically related to license renewal, may potentially have an effect on known or proposed historic sites. This determination is made irrespective of ownership or control of the lands of interest.

While preparing its application, DNC contacted your office by letter dated July 31, 2003. In its letter, DNC stated there are no plans to significantly alter current operations over the license renewal period. DNC further stated that no expansion of existing facilities is planned, and no major structural modifications have been identified for the purpose of supporting license renewal. In addition, no land-disturbing activities are anticipated beyond those required for routine maintenance and repairs. Your office responded in a letter dated August 5, 2003, stating that the proposed undertaking will have no effect on historic, architectural, or archaeological resources listed on or eligible for the National Register of Historic Places.

P. Loether 2

On May 18, 2004, the NRC will conduct two public NEPA scoping meetings at the Waterford Town Hall Auditorium, 15 Rope Ferry Road in Waterford, Connecticut. You and your staff are invited to attend. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is December 2004. If you have any questions or require additional information, please contact Mr. Richard L. Emch, Jr., Senior Project Manager at 301-415-1590 or RLE@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-336, 50-423

Enclosure: As stated

cc w/o encl.: See next page

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 8, 2004

Mr. Don Klima, Director
Office of Federal Agency Programs
Advisory Council on Historic Preservation
Old Post Office Building
1100 Pennsylvania Avenue, NW, Suite 809
Washington, DC 20004

SUBJECT: MILLSTONE POWER STATION, UNITS 2 AND 3 LICENSE RENEWAL REVIEW

Dear Mr. Klima:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application to renew the operating licenses for Millstone Power Station, Units 2 and 3 (MPS), which is located on the north shore of Long Island Sound in Waterford, Connecticut, approximately 40 miles southeast of Hartford, Connecticut. MPS is operated by Dominion Nuclear Connecticut Inc. (DNC). The application for renewal was submitted by DNC on January 22, 2004, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). The NRC has established that, as part of the staff review of any nuclear power plant license renewal action, a site-specific Supplemental Environmental Impact Statement (SEIS) to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437, will be prepared under the provisions of 10 CFR Part 51, which implements the National Environmental Policy Act of 1969 (NEPA). In accordance with 36 CFR 800.8, the SEIS will include analyses of potential impacts to historic and cultural resources. A draft SEIS is scheduled for publication in December of 2004, and will be provided to you for review and comment.

If you have any questions or require additional information, please contact the Senior Project Manager for the Millstone project, Mr. Richard L. Emch, Jr., at 301-415-1590 or RLE@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-336, 50-423

cc: See next page

April 14, 2004

The Honorable Matthew Thomas, Chief Sachem
Narragansett Indian Tribe
P.O. Box 268
Charlestown, RI 02813

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION REVIEW OF MILLSTONE POWER STATION, UNITS 2 AND 3 LICENSE RENEWAL APPLICATIONS

Dear Chief Thomas:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of applications from the Dominion Nuclear Connecticut, Inc. (DNC) to renew the operating licenses for the Millstone Power Station, Units 2 and 3 (MPS). MPS is located on the north shore of Long Island Sound in Waterford, Connecticut, approximately 40 miles southeast of Hartford, Connecticut. MPS is in close proximity to lands that may be of interest to the Narragansett Indian Tribe. As described below, the NRC process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to 10 CFR 51.28(b), the NRC invites the Narragansett Indian Tribe to provide input to the scoping process relating to the NRC's environmental review of the application. A copy of this letter is also being forwarded to Mr. John Brown, your Tribal Preservation Officer. In addition, as outlined in 36 CFR 800.8, the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for MPS Units 2 and 3 will expire in July 2015 and November 2025, respectively. DNC submitted its application for renewal of the MPS operating licenses on January 22, 2004.

The NRC is gathering information for a MPS-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the MPS site that are related to terrestrial ecology, aquatic ecology, hydrology, historic and archaeological resources, and socioeconomic issues (among others) and will contain a recommendation regarding the environmental acceptability of the license renewal action.

The NRC will hold two public scoping meetings for the MPS license renewal supplement to the GEIS on May 18, 2004, at the Waterford Town Hall Auditorium, 15 Rope Ferry Road in Waterford, Connecticut, 06385. There will be two sessions to accommodate interested parties. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session. To be considered, comments must be provided either at the transcribed public meetings or in writing. No formal comments on the proposed scope of the supplement to the GEIS will be accepted during informal discussions.

The application is electronically available for inspection from the Publicly Available Records component of NRC's Agencywide Documents Access and Management System (ADAMS) under Accession Number ML040260070. ADAMS is accessible at http://www.nrc.gov/reading-rm/adams.html which provides access through the NRC's Public Electronic Reading Room (PERR) link. If you do not have access to ADAMS or if there are problems in accessing the documents located in ADAMS, contact the NRC's Public Document Room (PDR) Reference staff at 1-800-397-4209, 1-301-415-4737, or by e-mail at pdr@nrc.gov. In addition, the application can be viewed on the Internet at http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html.

A paper copy of the application can be viewed at the NRC's PDR, located at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland, 20852-2738; the Waterford Public Library, located at 49 Rope Ferry Road, Waterford, Connecticut, 06385; and at the Thames River Campus Library at Three Rivers Community College, 574 New London Turnpike, Norwich, Connecticut, 06360. The GEIS, which assesses the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at the NRC's PDR.

Please submit any written comments that the Narragansett Indian Tribe may have to offer on the scope of the environmental review by June 4, 2004. Comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington D.C. 20555-0001, or by e-mail to *MillstoneEIS@nrc.gov*. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached and will mail a copy to you.

The NRC will issue the draft supplemental environmental impact statement (SEIS) for public comment (anticipated publication date, December 2004), and will hold another set of public meetings in the site vicinity to solicit comments on the draft. A copy of the draft SEIS will be sent to you for your review and comment. After consideration of public comments received on the draft, the NRC will prepare a final SEIS. The issuance of a final SEIS for MPS is planned for July 2005. If you need additional information regarding the environmental review process, please contact Mr. Richard L. Emch, Jr., Senior Environmental Project Manager, at (301) 415-1590.

Sincerely,

/RA/
Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-336, 50-423

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A paper copy of the application can be viewed at the NRC's PDR, located at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland, 20852-2738; the Waterford Public Library, located at 49 Rope Ferry Road, Waterford, Connecticut, 06385; and at the Thames River Campus Library at Three Rivers Community College, 574 New London Turnpike, Norwich, Connecticut, 06360. The GEIS, which assesses the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at the NRC's PDR.

Please submit any written comments that the Narragansett Tribal Community may have to offer on the scope of the environmental review by June 4, 2004. Comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington D.C. 20555-0001, or by e-mail to *MillstoneEIS@nrc.gov*. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached and will mail a copy to you.

The NRC will issue the draft supplemental environmental impact statement (SEIS) for public comment (anticipated publication date, December 2004), and will hold another set of public meetings in the site vicinity to solicit comments on the draft. A copy of the draft SEIS will be sent to you for your review and comment. After consideration of public comments received on the draft, the NRC will prepare a final SEIS. The issuance of a final SEIS for MPS is planned for July 2005. If you need additional information regarding the environmental review process, please contact Mr. Richard L. Emch, Jr., Senior Environmental Project Manager, at (301) 415-1590.

Sincerely,
/RA/
Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-336 and 50-423

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NAME	MJenkins*	JDavis*	REmch*	CMarco*	JTappert	PTKuo
DATE	03/29/04	03/29/04	03/29/04	04/7/04	04/13/04	04/14/04

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Millstone Power Station, Units 2 and 3

cc

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Waterford, CT 06385

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Director, Division of Radiation
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Nuclear Engineer
Massachusetts Municipal Wholesale
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Site Vice President
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Rope Ferry Road
Waterford, CT 06385

Mr. Chris L. Funderburk
Director, Nuclear Licensing and
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Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

Mr. David W. Dodson
Licensing Supervisor
Dominion Nuclear Connecticut, Inc.
Rope Ferry Road
Waterford, CT 06385

Millstone Power Station, Units 2 and 3

cc

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Mr. S. P. Sarver
Director - Nuclear Station Operations
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Mr. Fred Emerson
Nuclear Energy Institute
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Washington, DC 20006-3708

Ms. Judy Liskov, Assistant Director
Waterford Public Library
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Waterford, CT 06385

Three Rivers Community College
Thames River Campus Library
574 New London Turnpike
Norwich, CT 06360

Mr. John Brown
Tribal Preservation Officer
Narragansett Indian Tribe
P.O. Box 700
Wyoming, RI 02898

April 14, 2004

The Honorable Michael J. Thomas, Chairman
Mashantucket Pequot Tribal Nation
P.O. Box 268, Indian Town Road
Mashantucket, CT 06339-3060

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION REVIEW OF MILLSTONE POWER STATION, UNITS 2 AND 3 LICENSE RENEWAL APPLICATIONS

Dear Chairman Thomas:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of applications from the Dominion Nuclear Connecticut, Inc. (DNC) to renew the operating licenses for the Millstone Power Station, Units 2 and 3 (MPS). MPS is located on the north shore of Long Island Sound in Waterford, Connecticut, approximately 40 miles southeast of Hartford, Connecticut. MPS is in close proximity to lands that may be of interest to the Mashantucket Pequot Tribal Nation. As described below, the NRC process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to 10 CFR 51.28(b), the NRC invites the Mashantucket Pequot Tribal Nation to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8, the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for MPS Units 2 and 3 will expire in July 2015 and November 2025, respectively. DNC submitted its application for renewal of the MPS operating licenses on January 22, 2004.

The NRC is gathering information for a MPS-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the MPS site that are related to terrestrial ecology, aquatic ecology, hydrology, historic and archaeological resources, and socioeconomic issues (among others) and will contain a recommendation regarding the environmental acceptability of the license renewal action.

The NRC will hold two public scoping meetings for the MPS license renewal supplement to the GEIS on May 18, 2004, at the Waterford Town Hall Auditorium, 15 Rope Ferry Road in Waterford, Connecticut, 06385. There will be two sessions to accommodate interested parties. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session. To be considered, comments must be provided either at the transcribed public meetings or in writing. No formal comments on the proposed scope of the supplement to the GEIS will be accepted during informal discussions.

The application is electronically available for inspection from the Publicly Available Records component of NRC's Agencywide Documents Access and Management System (ADAMS) under Accession Number ML040260070. ADAMS is accessible at http://www.nrc.gov/reading-rm/adams.html which provides access through the NRC's Public Electronic Reading Room (PERR) link. If you do not have access to ADAMS or if there are problems in accessing the documents located in ADAMS, contact the NRC's Public Document Room (PDR) Reference staff at 1-800-397-4209, 1-301-415-4737, or by e-mail at pdr@nrc.gov. In addition, the application can be viewed on the Internet at http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html.

A paper copy of the application can be viewed at the NRC's PDR, located at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland, 20852-2738; the Waterford Public Library, located at 49 Rope Ferry Road, Waterford, Connecticut, 06385; and at the Thames River Campus Library at Three Rivers Community College, 574 New London Turnpike, Norwich, Connecticut, 06360. The GEIS, which assesses the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at http://www.nrc.gov/reading-rm/pdr.html NRC's PDR.

Please submit any written comments that the Mashantucket Pequot Tribal Nation may have to offer on the scope of the environmental review by June 4, 2004. Comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington D.C. 20555-0001, or by e-mail to *MillstoneEIS@nrc.gov*. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached and will mail a copy to you.

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Sincerely,
/RA/
Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-336, 50-423

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Sincerely,

/RA/
Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-336 and 50-423

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DATE	03/25/04	03/25/04	03/25/04	04/7/04	04/13/04	04/14/04

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Millstone Power Station, Units 2 and 3

cc

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Mr. Evan W. Woollacott
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Mr. David W. Dodson
Licensing Supervisor
Dominion Nuclear Connecticut, Inc.
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Millstone Power Station, Units 2 and 3

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Director - Nuclear Station Operations
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Mr. Fred Emerson
Nuclear Energy Institute
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Ms. Judy Liskov, Assistant Director
Waterford Public Library
49 Rope Ferry Road
Waterford, CT 06385

Three Rivers Community College
Thames River Campus Library
574 New London Turnpike
Norwich, CT 06360

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

RE: License Renewal, Millstone Power Station, Units 2 & 3
Waterford, CT

April 15, 2004

Pao-Tsin Kuo
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Mr. Kuo:

I have reviewed your request for information on endangered and threatened species and their habitats for the above-referenced project. The following comments are provided in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543) and the Fish and Wildlife Coordination Act (48 Stat., 401, as amended; 16 U.S.C. 661 et seq.).

The following is a list of federally-protected and candidate species that may be in the vicinity of MPS and the associated transmission lines: the federally-endangered roseate tern (*Sterna dougallii dougallii*) nests on the Atlantic coast/islands, federally-threatened piping plover (*Charadrius melodus*) nests on the Atlantic coast, the federally-threatened puritan tiger beetle (*Cicindela puritana*) is found in Middlesex County, the federally-threatened small whorled pogonia (*Isotria medeoloides*) is found in Hartford/New Haven/Fairfield/New London/Windham/Tolland /Middlesex and Litchfield Counties, and the federally-threatened bald eagle (*Haliaeetus leucocephalus*) uses the entire state for migratory/nesting purposes. In addition, the New England cottontail (*Sylvilagus transitionalis*) has been proposed as a canditate for federal listing. The New England cottontail may be found in the vicinity of the MPS and associated transmission lines.

With regard to our concerns under the provisions of the Fish and Wildlife Coordination Act, we are unable to provide detailed comments on the potential effects of the proposed action on fish and wildlife resources at this time. We will provide further comments after we review the Supplemental Environmental Impact Statement.

Thank you for your cooperation and please contact me at 603-223-2541, extension 23, for endangered species questions, and contact Greg Mannesto of our Rhode Island office at 401-364-9124 for any other concerns you might have. In the future, in order to expedite your reply, please direct any inquiries of this nature to this office at the above address.

Sincerely yours,

Michael J. Amaral

Michael J. Amaral
Endangered Species Specialist
New England Field Office

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

April 27, 2004

Mr. Richard Emch
Environmental Project Manager
USNRC OWFN
11555 Rockville Pike
Rockville, MD 20852

and

Ms. P. F. Faggert
V.P. and Chief Env. Officer
Dominion
5000 Dominion Blvd.
Glen Allen, VA 23060

RE: Request to renew the operating licenses for
Units 2 and 3 of the Millstone Power Station in
Waterford, Connecticut
Dominion Nuclear Connecticut, applicant

Dear Mr. Emch and Ms. Faggert:

We are in receipt of a request for Federal coastal consistency concurrence for renewal of the operating licenses for Units 2 and 3 at the Millstone Power Station in Waterford, Connecticut. This consistency concurrence request was submitted pursuant to 15 CFR 930.50.

Continued operation of the Millstone Nuclear Power plant requires renewal of the NPDES permit previously issued for the discharge of cooling waters. A request for that permit renewal was submitted by the applicant in a timely fashion and is currently pending before the Department.

In the interest of permit coordination, we have elected to waive the separate Federal coastal consistency review for this particular operating license application. However, this waiver should not be construed as our determination that the proposed activities are consistent with Connecticut's approved coastal management program. Instead, the State of Connecticut will evaluate the consistency of this proposed activity for conformance with the relevant coastal management policies, standards and criteria in conjunction with the State's NPDES permit review process as required by the Connecticut Coastal Management Act [Connecticut General Statutes (CGS) sections 22a-90 through 22a-112].

Phone 860.424.3034 Fax 860.424.4054

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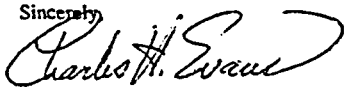
This waiver is provided in response to the Federal coastal consistency concurrence request and the supporting documentation submitted to this Office on January 27, 2004. Any subsequent modification, addition or deletion to the proposed activity, regardless of its magnitude or impact, constitutes a new application for the purposes of federal consistency certification. Accordingly, all such modifications, additions or deletions must be submitted to the State of Connecticut for a coastal consistency concurrence pursuant to 15 CFR 930.50.

If you have any questions regarding this matter, you may contact Margaret Welch of this Office via e-mail at margaret.welch@po.state.ct.us or by phone at 860.424.3034. Thank you.

Sincerely,



Charles H. Evans, Director
Office of Long Island Sound Programs

CHE/MLW/w

cc: Allison Castellan
Charles Nezianya
Edward Wilds

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

SEP 21 200

Pao-Tsin Kuo
Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation
US Nuclear Regulatory Commission
MS T-11 F1
Washington, DC 20555

Re: Millstone Power Station Units 2 and 3 license renewal

Dear Mr. Kuo,

This is in response to your letter dated March 17, 2004 requesting information on the presence of threatened, endangered, candidate and proposed species listed under the jurisdiction of the National Marine Fisheries Service (NOAA Fisheries) in the vicinity of the Millstone Power Station located on the north shore of Long Island Sound in Waterford, Connecticut. The US Nuclear Regulatory Commission (NRC) is reviewing an application submitted by Dominion Nuclear Connecticut Inc. (DNC) for the renewal of the operating licenses for Millstone Power Station, Units 2 and 3 (MPS). In support of this review, the NRC is currently preparing a Supplemental Environmental Impact Statement (EIS).

Four species of federally threatened or endangered sea turtles under the jurisdiction of the National Marine Fisheries Service (NOAA Fisheries) may be found seasonally in the waters of Long Island. Sea turtles are expected to be in the vicinity of the project area in warmer months, typically from May 1 to November 15. The sea turtles in northeastern nearshore waters are typically small juveniles with the most abundant being the federally threatened loggerhead (*Caretta caretta*) followed by the federally endangered Kemp's ridley (*Lepidochelys kempi*). Loggerhead turtles have been found to be relatively abundant off the Northeast (from near Nova Scotia, Canada to Cape Hatteras, North Carolina). From November to March in 1985 through 1988, 130 cold-stunned turtles were collected along the Long Island shoreline, including 97 Kemp's ridleys. The waters of Long Island Sound have also been found to be warm enough to support federally endangered green sea turtles (*Chelonia mydas*) from June through October. The three species of chelonid turtles found in the Northeast remain very briefly in open ocean waters, spending most of their time during the summer months in harbors and estuarine waters. Federally endangered leatherback sea turtles (*Dermochelys coriacea*) may be found in the waters of Long Island Sound during the warmer months as well.

Federally endangered North Atlantic right whales (*Eubalaena glacialis*), humpback whales (*Megaptera novaeangliae*), and fin whales (*Balaenoptera physalus*) may all also be found seasonally in Northeast waters. North Atlantic right whales have been documented in the nearshore waters of New York from January through September. Humpback whales feed during the spring, summer, and fall over a range that encompasses the eastern coast of the United States. Fin whales are common in waters of the United States Exclusive Economic Zone, principally offshore from Cape Hatteras northward. While these whale species are not considered residents of Long Island Sound, it is possible that transients may enter the area during seasonal migrations.

The entrainment and impingement of sea turtles at several nuclear power plants on the East Coast has been documented. As sea turtles may be seasonally present in the vicinity of the intakes associated with the MPS, NOAA Fisheries recommends that this impact be fully addressed in the SEIS being prepared in anticipation of license renewal actions. NOAA Fisheries staff look forward to reviewing the SEIS and will be available to NRC staff to discuss any potential impacts on listed species. Please contact Julie Crocker of my staff ((978)281-9328 x6530 or julie.crocker@noaa.gov) if you would like to set up a conference call or meeting.

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, states that each Federal agency shall, in consultation with the Secretary, insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Any discretionary federal action that may affect a listed species must undergo Section 7 consultation. As listed species may be present in the project area, the NRC is responsible for determining whether the proposed action is likely to affect any listed species. The NRC should then submit their determination along with a request for concurrence, to the attention of the Endangered Species Coordinator, NOAA Fisheries, Northeast Regional Office, Protected Resources Division, One Blackburn Drive, Gloucester, MA 01930. After reviewing this information, NOAA Fisheries would then be able to conduct a consultation under section 7 of the ESA.

Should you have any questions about these comments or about the section 7 consultation process in general, please contact Julie Crocker at (978)281-9328 ext. 6530.

Sincerely,

Mary A. Colligan
Assistant Regional Administrator
for Protected Resources

Cc: Ludwig, F/NER4

File Code: Sec 7 NRC Millstone Nuclear Power Plant

STATE OF CONNECTICUT

COMMISSION ON CULTURE AND TOURISM

October 6, 2004

Mr. Pao-Tsin Kuo
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Millstone Power Station
Units 2 and 3 License Renewal
Waterford, CT

Dear Mr. Kuo:

The State Historic Preservation Office has reviewed the above-named project. This office expects that the proposed undertaking will have no effect on historic, architectural, or archaeological resources listed on or eligible for the National Register of Historic Places.

This office appreciates the opportunity to have reviewed and commented upon the proposed undertaking.

We recommend that the responsible agency provide concerned citizens with the opportunity to review and comment upon the proposed undertaking in accordance with the National Historic Preservation Act and the Connecticut Environmental Policy Act.

For further information please contact Dr. David A. Poirier, Staff Archaeologist.

Sincerely,

J. Paul Loether
Division Director and Deputy
State Historic Preservation Officer

A106

Historic Preservation and Museum Division
Amos Bull House, 59 South Prospect Street, Hartford, Connecticut 06106
860-566-3005 860-566-5078 fax

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 9, 2004

Ms. Patricia A. Kurkul, Regional Administrator
NOAA Fisheries
Northeast Regional Office
One Blackburn Drive
Gloucester, MA 09130-2298

SUBJECT: REQUEST FOR CONCURRENCE - BIOLOGICAL ASSESSMENT FOR MILLSTONE POWER STATION, UNITS 2 AND 3 LICENSE RENEWAL

Dear Ms. Kurkul:

The U.S. Nuclear Regulatory Commission (NRC) has prepared the enclosed biological assessment (BA) to evaluate whether the proposed renewal of the Millstone Power Station, Units 2 and 3 (MPS) operating licenses for a period of an additional 20 years would have adverse effects on listed species. The proposed action (license renewal) is not a major construction activity. MPS is located on the north shore of Long Island Sound in Waterford, Connecticut, approximately 40 miles southeast of Hartford, Connecticut.

By letter dated March 17, 2004, to the National Oceanic and Atmospheric Administration (NOAA) - Fisheries, the NRC requested a list of Federally threatened or endangered aquatic species that may be in the vicinity of MPS and its associated transmission lines. In a letter dated September 21, 2004, NOAA Fisheries provided a list of Federally threatened or endangered species. Your office identified one threatened and three endangered species of sea turtles that may be seasonally found in the waters of Long Island. These include the loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempi*), green turtles (*Chelonia mydas*), and leatherback turtles (*Dermochelys coriacea*). The letter also identified three other endangered species known to occur seasonally in Northeast waters, the North Atlantic right whales (*Eubalaena glacialis*), humpback whales (*Megaptera novaeangliae*), and fin whales (*Balaenoptera physalus*). The NRC has also included in its evaluation the endangered shortnose sturgeon (*Acipenser brevirostrum*); this species is known to occur in the Connecticut River, which flows into Long Island Sound approximately 10 miles east of the Millstone site.

In addition the staff also contacted U.S. Fish and Wildlife Service (FWS) by letter dated March 18, 2004, requesting a list of Federally threatened or endangered terrestrial species that may be in the vicinity of MPS. In a letter dated April 15, 2004, FWS identified the following terrestrial species: the endangered roseate tern (*Sterna dougallii dougallii*); the threatened piping plover (*Charadrius melodus*), puritan tiger beetle (*Cicindela puritana*), small whorled pogonia (*Isotria medeoloides*), and bald eagle (*Haliaeetus leucophalus*); and one candidate species, the New England cottontail (*Sylvilagus transitionalis*).

The staff has determined that license renewal for Millstone would have no effect on the puritan tiger beetle, shortnose sturgeon, loggerhead sea turtle, green sea turtle, leatherback sea turtle, Kemp's ridley sea turtle, piping plover, right whale, finback whale, and humpback whale. License renewal may affect, but is not likely to adversely affect, the bald eagle, roseate tern, New England cottontail, and small whorled pogonia.

P. Kurkul -2-

We are requesting your concurrence with our determination. In reaching our conclusion, the NRC staff relied on information provided by the licensee, on literature research and interviews with experts performed by NRC staff, and on information provided by FWS (i.e., including current listings of species provided by the FWS, Concord, New Hampshire, New England Field Office) and NOAA Fisheries (Northeast Regional Office).

If you have any questions regarding this BA or the staff's request, please contact Mr. Richard L. Emch, Jr., Senior Environmental Project Manager, at 301-415-1590 or via e-mail at rle@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-336 and 50-423

Enclosures: As stated

cc w/encl.: See next page

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 9, 2004

Mr. Marvin Moriarty, Regional Director
Northeast Regional Office
U.S. Fish and Wildlife Service
300 Westgate Center Drive
Hadley, MA 01035-9589

SUBJECT: REQUEST FOR CONCURRENCE - BIOLOGICAL ASSESSMENT FOR MILLSTONE POWER STATION, UNITS 2 AND 3 LICENSE RENEWAL

Dear Mr. Moriarty:

The U.S. Nuclear Regulatory Commission (NRC) has prepared the enclosed biological assessment (BA) to evaluate whether the proposed renewal of the Millstone Power Station, Units 2 and 3 (MPS) operating licenses for a period of an additional 20 years would have adverse effects on listed species. The proposed action (license renewal) is not a major construction activity. MPS is located on the north shore of Long Island Sound in Waterford, Connecticut, approximately 40 miles southeast of Hartford, Connecticut.

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M. Moriarty -2-

We are requesting your concurrence with our determination. In reaching our conclusion, the NRC staff relied on information provided by the licensee, on literature research and interviews with experts performed by NRC staff, and on information provided by FWS (i.e., including current listings of species provided by the FWS, Concord, New Hampshire, New England Field Office) and NOAA Fisheries (Northeast Regional Office).

If you have any questions regarding this BA or the staff's request, please contact Mr. Richard L. Emch, Jr., Senior Environmental Project Manager, at 301-415-1590 or via e-mail at rle@nrc.gov.

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Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-336 and 50-423

Enclosures: As stated

cc w/encl.: See next page

ENCLOSURE 1

BIOLOGICAL ASSESSMENT

Biological Assessment

Millstone Power Station
License Renewal Review

October 2004

Docket Numbers
50-336
50-423

U.S. Nuclear Regulatory Commission
Rockville, Maryland

1.0 Introduction

The U.S. Nuclear Regulatory Commission (NRC) issues operating licenses for domestic nuclear power plants in accordance with the provisions of the Atomic Energy Act of 1954, as amended, and NRC implementing regulations. The purpose and need for the proposed action (that is, renewal of an operating license) is to provide an option that allows electric power generation to continue beyond the term of the current nuclear power plant operating license, so future generating needs can be met if the operator and State regulatory agencies pursue that option.

Dominion Nuclear Connecticut, Inc. (Dominion) has prepared an environmental report in conjunction with its application for renewal of the Millstone Nuclear Plant, Units 2 and 3 (Millstone) operating licenses, as provided for by the following NRC regulations:

- Title 10, Energy, Code of Federal Regulations (CFR) Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," Section 54.23, Contents of application - environmental information (10 CFR 54.23).

- Title 10, Energy, CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Section 51.53, Postconstruction environmental reports, Subsection 51.53(c), Operating license renewal stage [10 CFR 51.53(c)].

The NRC is reviewing an application submitted by Dominion (the applicant) for the renewal of the operating licenses for Millstone for a period of an additional 20 years. There will be no major construction, refurbishment, or replacement activities associated with this action. This biological assessment examines the potential effects of the continued operation of Millstone on 14 Federally listed species and one species proposed for candidate listing that could occur within the Millstone site, near the site, or along its associated transmission line rights-of-way (ROWs). This consultation is pursuant to Section 7(a)(2) of the Endangered Species Act.

In letters dated March 17 and 18, 2004, the NRC requested that the National Oceanographic and Atmospheric Administration (NOAA) - Fisheries (also known as the National Marine Fisheries Service or NMFS) and the U.S. Fish and Wildlife Service (FWS), respectively to provide lists of Federally listed endangered or threatened species and information on protected, proposed, and candidate species, as well as any designated critical habitat, that may be in the vicinity of Millstone and its associated transmission line ROWs (NRC 2004a, 2004b). The project area is defined as the Millstone site, its associated transmission line ROWs, and adjacent areas of Long Island Sound. In letters from the FWS (FWS 2004a) and the NMFS (NMFS 2004a), the NRC was provided a list of Federally protected species in the project area. A total of eight aquatic and six terrestrial species afforded protection under the Endangered Species Act of 1973 or candidates for such protection were identified that could potentially inhabit the project area.

2.0 Proposed Action

The proposed action is the renewal of the operating licenses for Millstone. The current operating license for Unit 2 expires on July 31, 2015, and for Unit 3 on November 25, 2025. Dominion has submitted an application to the NRC to renew these operating licenses for an additional 20 years of operation (i.e., until July 31, 2035, for Unit 2 and November 25, 2045, for Unit 3). The renewed licenses, if issued, will be effective from their date of issuance until 20 years after the expiration date of the current operating licenses.

Millstone is located on Millstone Point in Niantic Bay, between the Niantic and Thames Rivers on Long Island Sound, near Waterford in New London County, Connecticut (Figure 1). The nearest large cities are New Haven, approximately 64 km (40 mi) to the west, and Hartford, approximately 64 km (40 mi) to the northwest. The site is situated on the edge of Long Island Sound and Niantic Bay and is approximately 32 km (20 mi) west of Rhode Island. At one time, there were three operating nuclear power plants at the Millstone site. Construction on Unit 1 began in 1966, on Unit 2 in 1970, and on Unit 3 in 1974. Unit 1 was a boiling-water reactor that was permanently shut down in 1995. The facility is in long-term storage awaiting decontamination and dismantlement as part of station decommissioning. Unit 1 is not part of this license renewal application. Millstone Unit 2 is a two-loop, closed-cycle, pressurized-water nuclear reactor with a calculated electrical output of approximately 870 megawatts electric (MW[e]); while Millstone Unit 3 is a four-loop, closed-cycle, pressurized-water nuclear reactor with a calculated electrical output of approximately 1,154 MW(e) (Dominion 2004a).

Long Island Sound is the source of water for the once-through turbine condenser cooling systems at Millstone. The system withdraws salt water from Long Island Sound though intakes, pumps the water through the condenser for cooling, and surface discharges heated water to Long Island Sound approximately 610 m (2000 ft) southeast of the withdrawal points (Dominion 2004a).

Intake structures for Units 2 and 3 are located on the eastern shore of Niantic Bay, which is fed by Long Island Sound (Figure 2). The structures consist of four reinforced-concrete bays for Unit 2 and six bays for Unit 3. When both Units 2 and 3 are operating at full power, the 10 pumps (one for each bay) pump a total of 92 m^3/s (1.46 million gpm) into 2-m (7-ft) diameter conveyance pipes. Cooling water then moves through the condensers. After passing through each unit's condensers, cooling water is discharged to the former granite quarry. The heated discharge water then flows through two cuts excavated from the bedrock at the eastern end of the quarry into Long Island Sound. Figure 2 shows the intake structures, quarry, and discharge points for the Millstone circulating water system.

The intake structures are designed to minimize the possibility of clogging or impingement of aquatic organisms. Before the intake water reaches the circulating water pumps, the water passes through trash racks consisting of 1-cm (3/8-in. thick) metal bars spaced horizontally on 5-cm (2-in.) centers. The water then flows through vertical traveling screens with 1-cm (3/8-in.) mesh that prevent debris and large organisms from entering the cooling system. A cutoff wall in front of the intake extends 2.7 m (9 ft) below the surface to prevent surface water debris and organisms from entering the intake. Individual trash and fish return troughs collect and sluice debris and fish from the screens. Unit 3 was originally constructed with a fish return trough;

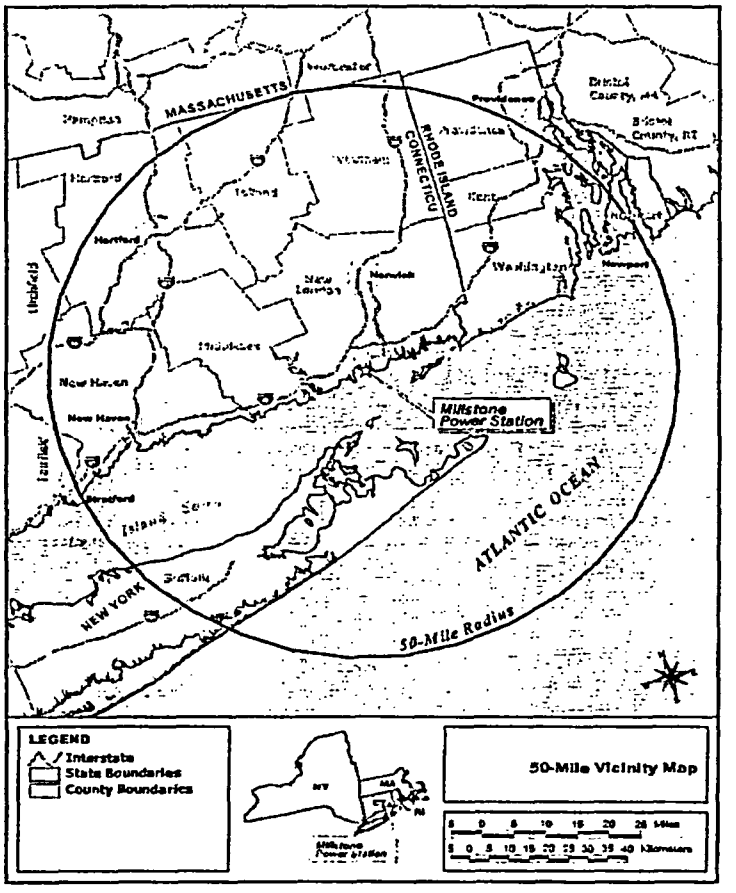

Figure 1. Location of Millstone, 80-km (50-mi) Region

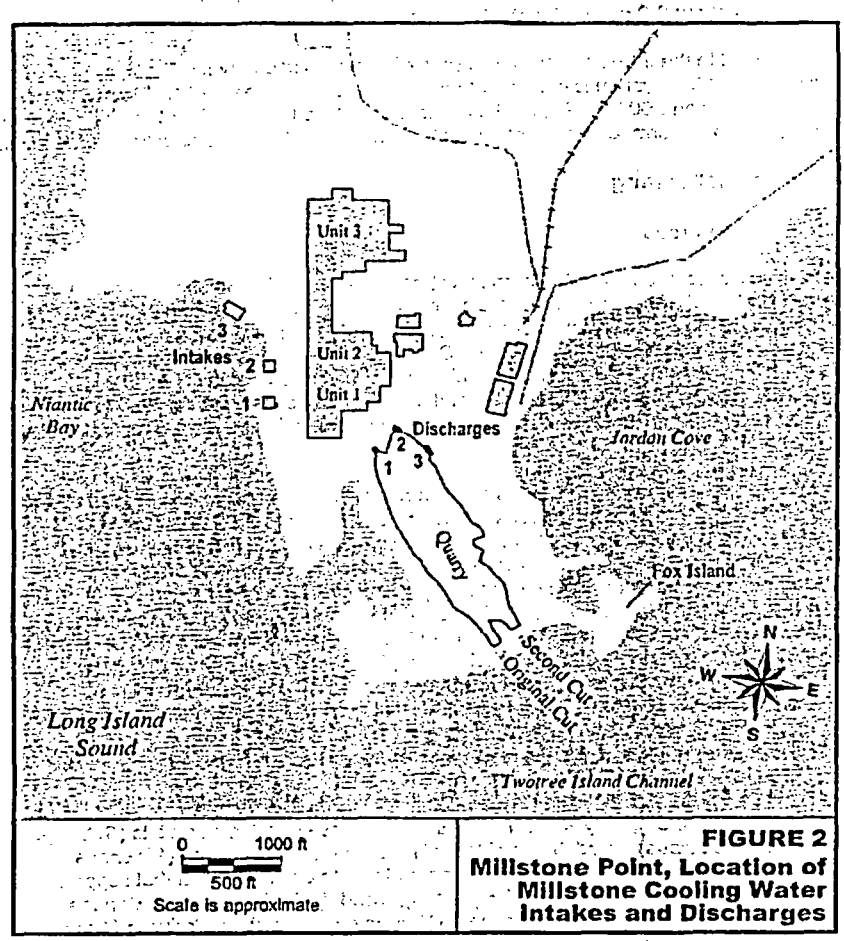

Figure 2. Millstone Point, Location of Millstone Cooling Water Intake and Discharges

a fish return trough was added to Unit 2 in 2000. Water velocity in front of the Unit 2 structure is estimated to be about 0.2 m/s (0.6 ft/s) (Dominion 2004a).

Biocides are added to the intake water to prevent biofouling. Sodium hypochlorite is injected on a periodic basis, and the system is designed to maintain a 0.2 parts per million (ppm) chlorine concentration (Dominion 2004a). Residual chlorine is monitored in the effluent water. Thermal backwashing is also performed to prevent mussels from fouling the intake structure pump bays.

3.0 Environmental Setting

3.1 Terrestrial Resources

The Millstone site is located in the Southern New England Coastal Plains and Hills of the Northeastern Coastal Zone ecoregion (U.S. Environmental Protection Agency [EPA] 2004a). Pre-settlement vegetation would have consisted primarily of winter deciduous hardwood forests with some salt marsh and beach habitat types. Out of approximately 212 ha (525 ac) that comprise the Millstone site, current land use includes approximately 89 ha (220 ac) of developed area, a 20-ha (50-ac) natural area, and a 12-ha (30-ac) ballpark licensed to the town of Waterford. Until 1960, the site was used as a granite quarry, which operated for 200 years (Dominion 2004a).

The current terrestrial environment includes old field habitats dominated by eastern red cedar (*Juniperus virginiana*), scarlet oak (*Quercus coccinea*), black cherry (*Prunus serotina*), and blackberry (*Rubus* spp.) (Dominion 2004a). Common invasive exotics in this habitat include multiflora rose (*Rosa multiflora*) and Japanese honeysuckle (*Lonicera japonica*). Winter deciduous hardwood forest dominated by various species of oak (*Quercus* spp.), pignut hickory (*Carya glabra*), black birch (*Betula lenta*), red maple (*Acer rubrum*), and American beech (*Fagus grandifolia*) is the most common undisturbed habitat type. Along the coast, beach and coastal marsh habitats are dominated by beach grass (*Ammophila breviligulata*), toadflax (*Linaria vulgaris*), evening primrose (*Oenothera biennis*), seaside goldenrod (*Solidago sempervirens*), salt meadow grass (*Spartina patens*), salt grass (*Distichlis spicata*), Bigelow's glasswort (*Salicornia bigelovii*), and smooth cordgrass (*Spartina alterniflora*). Ponds and wetlands in the eastern portion of the site are managed as a wildlife refuge.

Terrestrial habitats on the Millstone site support common wildlife species such as white-tailed deer (*Odocoileus virginianus*), gray squirrel (*Sciurus carolinensis*), cottontail rabbits (*Sylvilagus* spp.), red fox (*Vulpes vulpes*), woodchucks (*Marmota monax*), and wild turkey (*Meleagris gallopavo*). Coastal marshes and the wildlife refuge on the site contain habitat that supports waterfowl such as mallard ducks (*Anas platyrhynchos*), wood ducks (*Aix sponsa*), Canada geese (*Branta canadensis*), common mergansers (*Mergus merganser*), black ducks (*Anas rubripes*), herons, and egrets. Osprey (*Pandion haliaetus*) nest platforms have been maintained at Millstone for over 35 years and 173 fledglings have been produced over that time period (Dominion 2004a).

Four 345-KV transmission lines connect Millstone to the power grid (Table 1) (Dominion 2004a). The ROWs traverse New London, Middlesex, Hartford, Tolland, and the northeast corner of New Haven counties. The four lines share a common ROW for 14.5 km (9 mi) north to Hunts

Brook Junction (Figure 3). At Hunts Brook Junction two lines run north in the same ROW to the Card Street Substation where one line continues on to the Manchester Substation, one line runs east to the Montville Station and one line runs west to the Southington Substation. All Millstone lines share ROWs with lines from other sources and would be maintained if Millstone ceased operating. Transmission lines traverse abandoned fields, pasture, cultivated fields, forests, and wetlands as well as a number of conservation areas (Dominion 2004a). The Card Street/Manchester line crosses the Pease Brook Wildlife Management Area. The Southington line crosses the Nehantic State Forest, Cockaponset State Forest, and Hartman Park, a municipal park owned by the town of Lyme, Connecticut.

Table 1. Millstone Transmission Line Corridors.

		Length		Width		Max Area[a]	
Substation	kV	km	(mi)	m	(ft)	ha	(ac)
Hunts Brook Junction	345	14	(9)	152	(500)	220	(545)
Montville	345	6	(4)	99	(325)	64	(158)
Card Street	345	32	(20)	91	(300)	294	(727)
Manchester	345	61	(38)	91	(300)	559	(1382)
Southington	345	71	(44)	76	(250)	539	(1333)

[a] Max area calculations use maximum right-of-way width estimates (Dominion 2004a).

Connecticut Light and Power (CL&P), a subsidiary of Northeast Utilities conducts maintenance activities on these transmission lines and ROWs. These activities include, but are not restricted to, maintenance of vegetation in each ROW, replacement of poles or towers, installation of lightning arresters and counterpoise, and upgrading of existing equipment.

CL&P manages vegetation within the ROWs with an approach it calls "two-zone maintenance" (NU 2004). The area directly beneath the transmission lines and extending out 4.5 m (15 ft) on either direction is called the "wire zone." Most vegetation in the wire zone is kept short except for the occasional clusters of eastern red cedar that are maintained for nesting habitat. The area from the edge of the wire zone to the outside edge of the ROWs is called the "side zone." The side zone acts as a transition between the towers and conductors of the wire zone and the forest. The side zone is maintained as a multi-layered habitat with low growing trees and shrubs.

Vegetation is managed through a combination of mowing, trimming, and herbicide treatments. All personnel applying herbicides are required to possess a valid applicator's license (NU 2004). Wetlands and other water bodies are protected from herbicides by a 3-m (10-ft) vegetative border (NU 2004). Mowing is conducted only between the months of November and April to minimize impacts to wet soils, nesting birds, and wildlife forage. The Connecticut Department of Environmental Protection (CTDEP) reviews all ROW management plans to assure protection

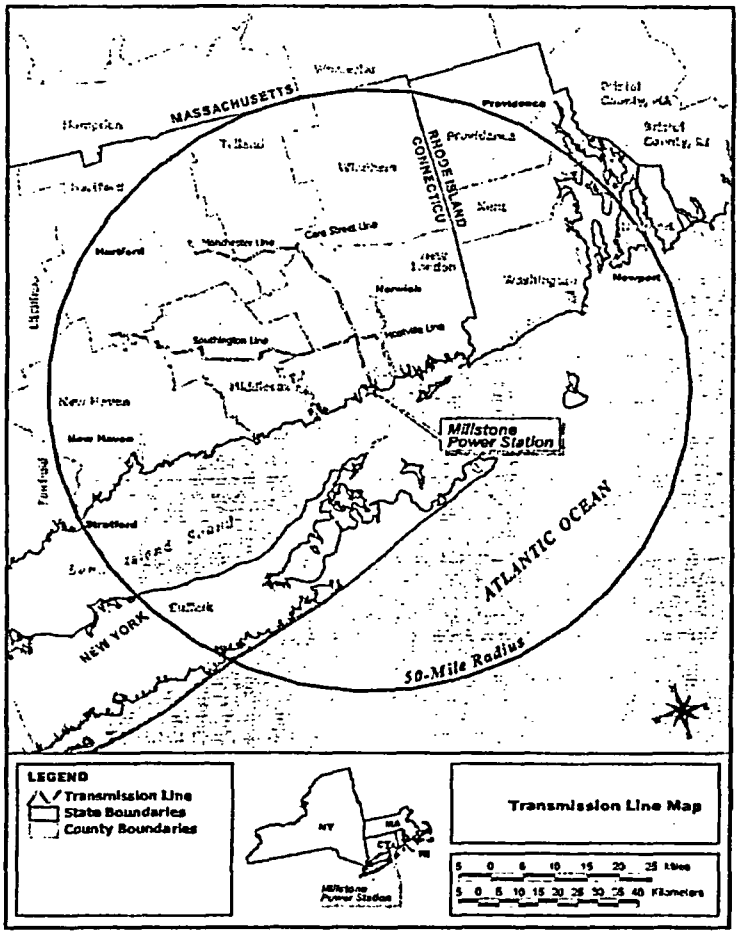

Figure 3. Millstone Site and Associated Transmission Lines

of threatened and endangered species. CL&P personnel work closely with maintenance crews to ensure that treatments are implemented properly.

CL&P encourages collaboration with conservation groups to use the ROWs for wildlife habitat improvement. It has also developed a list of plant species and wildlife habitat types that it attempts to promote through its vegetation management actions. Contractors are required to identify and target non-native, invasive plant species (NU 2004).

3.2 Aquatic Resources

Aquatic resources in the vicinity of Millstone are primarily associated with marine and estuarine environments that are part of Long Island Sound. Millstone is bordered on the west by Niantic Bay, to the east by Jordan Cove, and to the south by the Twotree Island Channel (Dominion 2004b). The plant is located approximately 1.6 km (1 mi) southeast of the mouth of the Niantic River, and approximately 5.5 km (3.5 mi) west of the Thames River. Cooling water intakes are located in Niantic Bay on the western shoreline of Millstone Point and are situated approximately 4.6 to 7.6 m (15 to 25 ft) below mean sea level. Once-through cooling water is discharged into an abandoned granite quarry located in approximately the center of Millstone Point. Water then flows from the quarry over a weir into Long Island Sound near the Twotree Island Channel (Figure 2). Rated flows for Millstone Units 2 and 3 are 36 and 59 $m^3 s^{-1}$ (1275 and 2097 $ft^3 s^{-1}$) respectively.

Long Island Sound is a large water body, with a surface area of 3420 km^2 (1320 mi^2), and 965 km (600 mi) of coastline. The drainage area associated with the water body is approximately 27,070 km^2 (16,820 mi^2). The average depth of the sound is 19 m (63 ft); and the approximate volume is 68 trillion L (18 trillion gallons). Millstone Point lies on the western shore of Long Island Sound, near the mouth of the sound. This area of Long Island Sound experiences a salinity of approximately 23 parts per thousand due to the influence of three major rivers: the Thames, the Housatonic, and the Connecticut Rivers. Ambient water temperature near the Millstone cooling water intakes can range from 1°C to 22°C (34°F to 72°F) over the course of a year. Linear regression performed on daily and annual seawater temperatures near Millstone over a 25-year period revealed a significant long-term increase in water temperature of 1.55°C (2.8°F) based on daily means and 1.01°C (1.8°F) based on annual means (Keser et al. 2003).

Millstone Point is situated approximately 5.6 km (3.5 mi) west of the Thames River, in an area that experiences strong tidal currents that influence the nearshore ecosystem, which include rocky coastlines and boulder and gravel substrate beaches that support a variety of fish, invertebrate, and marine plant life . The average tidal flow through Twotree Island Channel is approximately 3400 $m^3 s^{-1}$ (1.2×10^6 $ft^3 s^{-1}$) with a maximum flow of about 8500 $m^3 s^{-1}$ (3.0×10^6 $ft^3 s^{-1}$). This translates into current velocities of about 1.8 to 3.30 km hr^{-1} (1 to 1.8 knots), with slightly lower velocities near the plant. Weak currents predominate in both the Niantic River and Jordan Cove. Tidal fluctuation in this area is not severe, with mean and maximum ranges of 0.8 and 1.0 m (2.6 to 3.3 ft), respectively (Dominion 2004b).

EPA Region 1 has identified Long Island Sound as "an estuary of national significance" and listed six problem areas of concern associated with water quality (EPA 2004b):

1. Low dissolved oxygen (hypoxia)
2. Toxic contamination
3. Pathogen contamination
4. Floatable debris
5. Habitat degradation and loss, and living resource health associated with items 1-4
6. Land use and development resulting in habitat loss and degradation of water quality

These problem areas have resulted in a variety of long-term, integrated studies of Long Island Sound by both state and Federal agencies.

- **Chemical Contaminants Near Millstone**

Specific chemical data associated with sediment, water, or biota near the Millstone study area were not available for review, but in general, surficial sediment associated with the eastern portion of Long Island Sound exhibits lower levels of common contaminants (heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides) than the western portion. United States Geological Survey (USGS) data (Mecray et al. 2004) showed regional patterns of high metals concentrations in the western sound, with relatively low concentrations associated with the eastern sound in the vicinity of Millstone. Draft data (Battelle 1999) associated with surficial samples from the Thames River indicated most metals were below NOAA effects-range-median (Long et al. 1998), and organic constituents were at or near detection limits with the exception of the PAH, perylene, which was detected at concentrations ranging from approximately 20 to 1200 µg/kg dry weight. It is suspected the source of this compound is biogenic rather than anthropogenic.

A citizens' group conducted limited chemical and radiological monitoring of bottom sediments in the vicinity of Millstone and reported possible elevated levels of hydrazine and uranium in the bottom sediments of Jordon Cove (CTDEP 2002). The chemical compound 1,1-dimethylhydrazine (UMDH) was reported as detected in two sediment samples at low levels. It was postulated that the UMDH might be due to hydrazine used at Millstone for corrosion control. CTDEP reviewed available information and concluded that the detections likely were false positives because of questionable quality of the analytical procedures, and it was unlikely that hydrazine could accumulate in bottom sediments because it degrades rapidly into water and nitrogen. In addition, the particular chemical form of hydrazine used at Millstone is different than UMDH. There are also industrial facilities in the area that commonly use hydrazine. CTDEP also concluded that the types and levels of uranium measured in sediments near Millstone reflected naturally occurring background levels (CTDEP 2002). Neither concern was judged by CTDEP to be sufficiently credible to warrant further investigation.

- **Important Fish and Shellfish Communities Near Millstone**

A variety of commercially, recreationally, or environmentally important fish and shellfish live or spend a portion of their life cycle in the vicinity of Millstone, and also commonly occur in Long

Island Sound (Table 2). Many of these species live in the waters near Millstone, travel through the area during their seasonal migrations in and out of Long Island Sound, or pass close to the plant as they enter rivers adjacent to Millstone during their spawning seasons. Because of their proximity to Millstone, they may be susceptible to entrainment, impingement, or to lethal or sublethal effects associated with plant operations. In order to assess relative species abundance near Millstone operations, a variety of collection and enumeration methods have been employed, including sampling cooling water discharge using plankton nets to determine ichthyoplankton (fish eggs and larvae) abundance, shore-zone seines to capture small fish, and bottom trawls to capture larger, demersal fish (Dominion 2004b). In general, assessments of fish and shellfish have included sampling stations in direct proximity to the plant (e.g., within a radius of approximately 3 km [2 mi]). Sampling stations have included a station located near the Unit 2 and 3 cooling water discharge, stations in the Niantic River and Bay, and stations in Jordan Cove. Far-field reference sites were not included in the fish and shellfish monitoring programs, nor were sampling grids located at varying distances from the area of interest to identify environmental gradient effects. Plume dynamic studies and assessments of intertidal ecosystems, however did use far-field reference or control sites.

Table 2. Important Fish and Shellfish Species.

Common Name	Scientific Name
winter flounder	*Pseudopleuronectes americanus*
lobster	*Homarus americanus*
American sandlance	*Ammodytes americanus*
anchovy	*Anchoa* spp.
silversides	*Menidia* spp.
grubby	*Myoxocephalus aenaeus*
cunner	*Tautogolabrus adspersus*
tautog	*Tautoga onitis*

Eelgrass Community

Eelgrass (*Zostera marina*) is one of the dominant seagrasses in coastal regions of the northern hemisphere, and common in eastern Long Island Sound near the Millstone facility. This seagrass is important because of its significant influence on the nearshore environment. Eelgrass beds provide habitat and cover for many larval and juvenile forms of fish and invertebrates, support significant primary and secondary production, and serve as a food source for numerous waterfowl or planktonic grazers (Kesar et al., 2003). Eelgrass beds in the vicinity of Millstone have been monitored for many years to evaluate population dynamics and document change over time. Sampling locations included areas associated with thermal plume discharge (Jordan Cove, White Point), and reference locations associated with the Niantic River (Dominion 2004b). Studies near Millstone and in Long Island Sound have shown considerable variation in the extent of eelgrass beds at all locations, probably due to water body temperature

fluctuations, eutrophication, sedimentation, turbidity, the presence of nuisance organisms (mussels and green algae blooms) and possible changes associated with nearshore hydrodynamics. Studies conducted at Millstone have suggested that eelgrass abundance and distribution at Jordan Cove and White Point has been affected by the thermal plume discharge, but have observed relative stable biomass and distribution over the past 16 years at other locations adjacent to the facility (Dominion 2004b). Studies have also noted dramatic changes in eelgrass populations in the Niantic River, resulting in multiple relocations of reference sites over the past 20 years due to die-off that is attributable to poor water quality and potential biological disturbances (Dominion 2004b).

Rocky Intertidal Communities

A rich and varied rocky intertidal habitat exists in the region surrounding Millstone, and includes marine alga, polychaeteous annelids, crustaceans, and molluscs. All of these organisms are important contributors to the structure and function of nearshore ecosystems. Environmental studies conducted by Dominion have included sites at Fox Island, Millstone Point, White Point, and a reference location near Giant's Neck (Figure 2). Cooling water discharge stations have included a location close to the quarry cuts and one location approximately 200 m (660 ft) southeast of the quarry cut. Millstone monitoring programs have been in effect since 1979 and are intended to provide 1) an environmental baseline of abundance of important species, and 2) a means to detect change in community structure and function near the Millstone facility.

Algal studies have been conducted since 1979, and have identified over 140 species that occur or have occurred in the area during the study duration. Dominion scientists have data on organisms that represent the more common marine flora or fauna, including barnacles, the algae *Fucus* spp., the red alga *Chondrus* spp., and the marine mussel *Mytilus edulis*. Community analyses using clustering techniques suggest that plant impacts are generally limited to approximately 150 m (490 ft) of shoreline on the east side of the discharge to Long Island Sound (Dominion 2004b). Detectable changes at the community level have been observed in the study area, as have ecosystem-level changes (e.g. water temperature fluctuations, nutrient concentrations, light intensity). Of particular note is the presence of the red alga *Antithamnion pectinatum*, an exotic species native to the Pacific Ocean that was not previously reported in the Atlantic.

Benthic Infauna

Benthic infaunal communities near Millstone are consistent with soft-bottom, nearshore environments associated with New England. These communities typically contain a diverse assemblage of species that collectively contribute to the stability of the nearshore food web. Subtidal communities in the vicinity of Millstone and at a reference site located near Giants Neck have been sampled and studied since 1980. During the 2003 sampling, marine polychaetes were the most abundant taxa, followed by oligochaetes, arthropods, and molluscs (Dominion 2004b). The following infaunal taxa were selected as representative of sites affected by Millstone: oligochaetes, the polychaetes *Aricidea catherinae*, *Mediomastus ambiseta*, *Tharyx* spp., *Polycirrus eximius*, *Protodorvillea gaspeensis*, *Parapionosyllis longicirrata*, and the bivalve mollusc *Nuculana annulata* (Dominion 2004b). Monitoring studies have been helpful in detecting changes in benthic infauna community structure and linking the observed changes to

both natural and anthropogenic disturbances. Millstone activities relating to cooling water discharge and required maintenance dredging have produced observable effects to the structure of benthic communities in the immediate vicinity of the plant. This was clearly evident by the response of the benthic community during extended shutdowns during 1996-1998.

4.0 Assessment of Federally Listed Species

Several Federally listed species are known to occur in the vicinity of the Millstone site or associated transmission line ROWs. No FWS-designated critical habitat is found within the site or associated ROWs.

4.1 Aquatic Species

Eight Federally listed marine species could occur in Long Island Sound in the vicinity of Millstone. These include three species of whales and four species of turtle (NMFS 2004a, FWS 2004b) (Table 3). The staff has also evaluated the potential impacts of continued Millstone operation on the shortnose sturgeon (*Acipenser brevirostrum*). The shortnose sturgeon is a Federally listed endangered species that is found in the Connecticut River, which flows into Long Island Sound approximately 10 miles east of the Millstone site.

Table 3. Aquatic Endangered and Threatened Aquatic Species

Scientific Name	Common Name	Federal Status[a]
	FISH	
Acipenser brevirostrum	shortnose sturgeon	Endangered
	TURTLES	
Caretta caretta	loggerhead	Endangered
Chelonia mydas	green turtle	Threatened
Dermochelys coriacea	leatherback turtle	Endangered
Lepidochelys kempii	Kemp's Ridley	Endangered
	WHALES	
Balaena glacialis	right whale	Endangered
Balaenoptera physalus	finback whale	Endangered
Megaptera novaengliae	humpback whale	Endangered

(a) FWS 2004b, NMFS 2004a.

Shortnose Sturgeon (*Acipenser brevirostrum*)

The shortnose sturgeon is Federally listed as endangered in the entire range (FWS 2004b). Two populations of shortnose sturgeon are present in the Connecticut River. One of these is landlocked in the upper part of the river between the Holyoke dam and Turners Falls dam in Massachusetts, and the other population is located in the lower Connecticut River from the Holyoke Dam to Long Island Sound. An estimated 1200 to 1500 shortnose sturgeon are found in freshwater and estuarine portions of the Connecticut River and are presumed to occasionally

range into adjacent areas of Long Island Sound (FWS 2001). No shortnose sturgeon have been impinged or captured in more than 30 years of sampling at Millstone (Dominion 2004a). The primary threats to this species are dam building, water pollution, and dredging (NatureServe 2004).

Although this species has not been recorded for the area and it is highly unlikely that individuals could even occasionally be present. The intake structures at Dominion have been fitted with fish sluiceways that return fish and other organisms that become impinged during cooling water intake. It is unknown how impingement and returns affect mortality of shortnose sturgeon but it is expected that the mortality rate would be low. The species has a bottom orientation, it is a strong swimmer and its robustness would likely minimize the potential for impingement.

The staff reviewed the design, operation, and location of the intake and discharge structures at Millstone and the impingement and entrainment data collected during plant operation. The staff also visited the site and reviewed the life history information about the shortnose sturgeon. On the basis of this information, the staff has determined that the continued operation of Millstone over the 20-year renewal period will have no effect on the shortnose sturgeon.

Loggerhead (*Caretta caretta*)

The loggerhead sea turtle is Federally listed as threatened throughout its range (FWS 2004b). There are currently no critical habitats designated for this species, although the NMFS is currently working on a status review based on a 2002 petition to reclassify the Northern and Florida Panhandle subpopulations with endangered status and to designate critical habitat for both subpopulations (NMFS 2004b). The range for the Atlantic population of loggerheads extends from Newfoundland to Argentina, with primary nesting areas located in Florida, Georgia, and the Carolinas.

The NMFS (2004b) has noted that loggerheads can become impinged on intake structures of coastal power plants and estimates the mortality rate for impingement is 2 percent (NMFS 2004b). The applicant has not reported any incidences of impingement of loggerheads or incidental takes during trawling studies in over 30 years of sampling operations.

The staff reviewed the design, operation, and location of the intake and discharge structures at Millstone and the impingement and entrainment data collected during plant operation. On the basis of this information, and that previously provided for the aquatic resources in the vicinity of the plant, the staff has determined that continued operation of Millstone over the 20-year renewal period will have no effect on the loggerhead sea turtle.

Green Turtle (*Chelonia mydas*)

The green sea turtle is Federally listed as endangered in the breeding colony populations in Florida and on the Pacific coast of Mexico and threatened for all other areas (FWS 2004b). The western Atlantic population of green turtles ranges from Massachusetts south to the U.S. Virgin Islands and Puerto Rico, with important feeding grounds in Florida, and primary nesting sites on the east coast of Florida, the U.S. Virgin Islands and Puerto Rico (NMFS 2004c).

NMFS (2004c) has noted that green sea turtles can become impinged on intake structures of coastal power plants and estimates the impingement mortality for green sea turtles at 7 percent (NMFS 2004c). The applicant has not reported any incidences of impingement of green turtles or incidental takes during trawling studies in over 30 years of sampling operations.

The staff reviewed the design, operation, and location of the intake and discharge structures at Millstone and the impingement and entrainment data collected during plant operation. On the basis of this information, and that previously provided for the aquatic resources in the vicinity of the plant, the staff has determined that continued operation of Millstone over the 20-year renewal period will have no effect on the green turtle.

Leatherback Turtle (*Dermochelys coriacea*)

The leatherback sea turtle is Federally listed as endangered throughout its range (FWS 2004b). The western Atlantic population of leatherback sea turtles ranges from Nova Scotia to Puerto Rico and the U.S. Virgin Islands. During the summer, leatherbacks are typically found along the east coast of the U.S. from the Gulf of Maine to central Florida. Critical habitat designated in the area around the U.S. Virgin Islands, with nesting sites located from Georgia to the U.S. Virgin Islands (NMFS 2004d).

The primary threats to the survival of leatherback sea turtles include habitat destruction, incidental catch in commercial fisheries, and harvest of eggs and meat (NMFS 2004d). Impingement of leatherback sea turtles is not listed by NMFS as one of the human impacts on this species (NMFS 2004d). The applicant has not reported any incidences of impingement of leatherback turtles or incidental takes during trawling studies in over 30 years of sampling operations.

The staff reviewed the design, operation, and location of the intake and discharge structures at Millstone and the impingement and entrainment data collected during plant operation. On the basis of this information, and that previously provided for the aquatic resources in the vicinity of the plant, the staff has determined that continued operation of Millstone over the 20-year renewal period will have no effect on the leatherback turtle.

Kemp's Ridley (*Lepidochelys kempii*)

The Kemp's ridley sea turtle is Federally listed as endangered throughout its range (FWS 2004b). This species is found primarily in coastal areas of the Gulf of Mexico and the northwestern Atlantic, with a major nesting beach on the northeastern coast of Mexico (NMFS 2004e).

Habitat degradation, pollution, and ingestion of floating debris are among the most significant threats to Kemp's ridley sea turtles (NMFS 2004e). Impingement of Kemp's ridley was not listed in NMFS (2004e) as one of the human impacts on this species. The applicant did not report any incidences of impingement of Kemp's ridley or incidental takes during trawling studies in over 30 years of sampling operations.

The staff reviewed the design, operation, and location of the intake and discharge structures at Millstone and the impingement and entrainment data collected during plant operation. On the basis of this information, and that previously provided for the aquatic resources in the vicinity of the plant, the NRC concludes that continued operation of Millstone over the 20-year renewal period will have no effect on the Kemp's ridley.

Right Whale (*Eubalaena glacialis*)

The right whale is Federally listed as endangered throughout its range (FWS 2004b). With a population estimated at 291 individuals in 1998, the North Atlantic right whale is considered to be one of the most critically endangered populations of large whales in the world (NMFS 2002). This population ranges from wintering and calving grounds in the coastal waters of the southeastern United States to summer feeding and nursery grounds in New England waters and northward (NMFS 2002). In 1994, the NMFS designated three critical habitats for the North Atlantic right whale: Cape Cod Bay/Massachusetts Bay, Great South Channel, and the Southeastern USA. At the present time, injuries and mortality caused by ship strikes are the primary source of human impacts to right whales, with some additional impacts from fishery entanglements. Right whales have been sighted near Long Island Sound (NMFS 2004a), but are not known to move into the shallow waters immediately offshore of the Millstone site (Dominion 2004b).

On the basis of this information, and that previously provided for the aquatic resources in the vicinity of the plant, the staff has determined that continued operation of Millstone over the 20-year renewal period will have no effect on the right whale.

Finback Whale (*Balaenoptera physalus*)

The finback (fin) whale is Federally listed as endangered throughout its range (FWS 2004b). The current minimum population estimate from a 1999 survey for the western North Atlantic fin whale was 2362 (NMFS 2002). Fin whales are found principally in waters from North Carolina north to Nova Scotia. New England waters provide an important feeding ground for this species. There are no critical habitats designated for the fin whale, although a recovery plan has been drafted. At the present time, injuries and mortality caused by ship strikes are the primary source of human impacts to fin whales. It is possible that fin whales could enter Long Island Sound, but they are not known to move into the shallow waters immediately offshore of the Millstone site (Dominion 2004b).

On the basis of this information, and that previously provided for the aquatic resources in the vicinity of the plant, the staff has determined that continued operation of Millstone over the 20-year renewal period will have no effect on the fin whale.

Humpback Whale (*Megaptera novaengliae*)

The humpback whale is Federally listed as endangered throughout its range (FWS 2004b). The overall abundance for the North Atlantic humpback whale population was estimated in 1992/1993 at 11,570 individuals (NMFS 2002). North Atlantic humpback whales are found during the spring, summer, and fall over a range covering the eastern coast of the United

States. New England waters are an important feeding ground for this species. A recovery plan for humpback whales has been developed and implemented. Injuries and mortality from fishery entanglements and ship strikes are the primary human impacts on humpback whales. Disturbance from whale watching traffic is also of concern, particularly in coastal New England waters. It is possible that humpback whales could enter Long Island Sound, but they are not known to move into the shallow waters immediately offshore of the Millstone site (Dominion 2004b).

On the basis of this information, and that previously provided for the aquatic resources in the vicinity of the plant, the staff has determined that continued operation of Millstone over the 20-year renewal period will have no effect on the humpback whale.

4.2 Terrestrial Species

A total of five Federally listed and one potential candidate terrestrial species was identified (FWS 2004a) as having the potential to occur in New London county or counties traversed by transmission line ROWs (Middlesex, Hartford, Tolland, and the northeast corner of New Haven) (Table 4).

Table 4. Terrestrial Endangered and Threatened Species

Scientific Name	Common Name	Federal Status[a]
	INSECTS	
Cicindela puritana	Puritan tiger beetle	Threatened
	BIRDS	
Charadrius melodus	piping plover	Threatened
Haliaeetus leucocephalus	bald eagle	Endangered
Sterna dougallii dougallii	roseate tern	Endangered
	MAMMALS	
Sylvilagus transitionalis	New England cottontail	Proposed for Candidacy
	PLANTS	
Isotria medeoloides	small whorled pogonia	Threatened

(a) FWS 2004a, 2004b.

Puritan Tiger Beetle (*Cicindela puritana*)

The Puritan tiger beetle is Federally listed as threatened. This species is known from two disjunct populations, one along Chesapeake Bay in Maryland and one along the Connecticut River, in northern Connecticut (CTDEP 2004). Although this species is reported to occur in Middlesex County (FWS 2004b), CTDEP distribution maps clearly show the Connecticut population to be centered primarily along the Connecticut River in Hartford County (CTDEP 2004). The Millstone ROW for the Manchester transmission line does not cross the Connecticut River in Hartford County. The Puritan tiger beetle is restricted to sandy habitats typically found along river banks. Habitat has been depleted through riverbank stabilization and

flood control practices. There is no known habitat for this species near the Millstone site or within associated transmission line ROWs.

The staff has determined that continued operation of Millstone over the 20-year license renewal term will have no effect on the Puritan tiger beetle.

Piping Plover (*Charadrius melodus*)

The piping plover is Federally listed as threatened. This species is a shorebird that is found nesting in sandy beach habitats along seacoasts (CTDEP 2004). Piping plovers nest from North Carolina north to Nova Scotia. Nesting generally occurs from March through July. Historically, these birds were killed for consumption and the feathers used for adornment. Current threats include development and beach stabilization.

CTDEP range maps (CTDEP 2004) show piping plover habitat extending no further east than the east side of the mouth of the Connecticut River. There have been no reported sitings of piping plovers at the site. It is not likely that the necessary beach habitat for nesting is present in the vicinity of the site.

For these reasons, the staff has determined that continued operation of Millstone over the 20-year license renewal term will have no effect on the piping plover.

Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle is Federally listed as threatened. This species is a large raptor that is found along the coastline and around lakes and rivers. Eagles generally nest in tall trees or on cliff faces near water and away from human disturbance. Eagle populations have declined in the Connecticut due to loss of habitat, human disturbance, and pesticide contamination. There are reported to be up to 100 eagles wintering along major rivers and reservoirs in Connecticut (CTDEP 2004). There are no known nesting pairs near the Millstone site or along transmission corridors. However, individuals have been seen foraging in the area.

Although no bald eagles are known to nest at the Millstone site, Dominion does maintain a raptor reporting program and will follow CTDEP recommendations should bald eagles nest on the Millstone site. For these reasons, the staff has determined that continued operation of Millstone over the 20-year license renewal term may affect, but is not likely to adversely affect, the bald eagle.

Roseate Tern (*Sterna dougallii dougallii*)

The roseate tern is Federally listed as endangered. This species is a seabird that is found almost exclusively on saltwater coastlines. Roseate terns nest in colonies on coastal beaches and offshore islands. Historically, tern populations in Connecticut have been impacted by unrestricted market hunting and more recently by the expansion of predatory great black-backed and herring gull populations throughout their range in the state (CTDEP 2004).

Fox Island (Figure 2) is a small promontory extending off the Millstone site and into Long Island Sound. This site is used by multiple species of seabirds and it is known to be used by roseate terns during the fall migration period. Roseate terns are not known to nest in the vicinity of the Millstone site (Dominion 2004a). Fox Island is managed as a tern sanctuary in the fall and access is strictly controlled. For these reasons, the staff has determined that continued operation of Millstone over the 20-year license renewal term may affect, but is not likely to adversely affect, the roseate tern.

New England Cottontail Rabbit (*Sylvilagus transitionalis*)

The FWS is in the process of determining if the New England cottontail rabbit will be proposed for listing as a candidate species. Populations in Connecticut were considered abundant through the mid 1930s, but competition from introduced Eastern cottontails (*Sylvilagus floridanus*) and loss of agriculture-related habitat has led to a decline is numbers (CTDEP 2004). This species is found in brushy habitats associated with fencelines and edges of fields and forests. Transmission line corridors are not considered high quality habitat due to the abundance of perching raptors and other predators that use the corridors. However, the species may use corridors for dispersal from one site to another. Surveys of eastern and New England cottontail rabbits have found New England cottontail rabbits near the Millstone site and in areas crossed by transmission lines (Goodie et al. 2004). Considering the population trends of this species it is likely to be listed before or during the period of license renewal.

Vegetation management techniques used on the Millstone site and associated transmission line corridors maintain the early successional habitat types that the New England cottontail requires. The CTDEP reviews all ROW management plans to assure protection of threatened and endangered species. CL&P personnel work closely with maintenance crews to ensure that treatments are implemented properly. The staff has determined that with implementation of current management procedures and safeguards, continued operation of Millstone over the 20-year license renewal term may affect, but is not likely to adversely affect, the New England cottontail.

Small Whorled Pogonia (*Isotria medeoloides*)

The small whorled pogonia is Federally listed as threatened. This species occurs in isolated populations throughout the eastern United States. In Connecticut it is reported to occur in New London, Middlesex, Tolland, Hartford, and New Haven counties. New England populations of this orchid are found almost exclusively on acidic, well drained, fragipan (a subsurface impermiable layer) soils (NatureServe 2004). Common plant associates include red maple, eastern hemlock (*Tsuga canadensis*), paper birch (*Betula papyrifera*), northern red oak (*Quercus rubra*), eastern white pine (*Pinus strobus*), and American beech (*Fagus grandifolia*). Isotria populations are found in second growth and mature forests. The major threats to this species are habitat destruction through development and forestry.

Habitat for the small whorled pogonia may exist at the Millstone site or along associated transmission line ROWs. The Millstone site is covered by glacial soils (Dominion 2004a) which can have subsurface fragipan layers. Some of the common plant associates are found on the site (red maple, American beech). This plant has been recorded in the towns of Lyme and

Glastonbury, Connecticut but is not known to currently occur at these sites (NRC 1984). ROW maintenance activities should not greatly impact the small whorled pogonia as long as soil disturbance is minimized. Mowing of some portions of the transmission line ROWs is only conducted between the months of November and April to minimize impacts to wet soils (NU 2004).

The CTDEP reviews all ROW management plans to assure protection of threatened and endangered species. CL&P personnel work closely with maintenance crews to ensure that treatments are implemented properly. The staff has determined that with implementation of current management procedures and safeguards, continued operation of Millstone over the 20-year license renewal term may affect, but is not likely to adversely affect, the small whorled pogonia.

5.0 Conclusions

The staff identified six terrestrial and eight aquatic species listed as threatened, endangered, or proposed for candidate under the Endangered Species Act that have a reasonable potential to occur in the vicinity of Millstone, along associated transmission line ROWs, or in adjacent areas of Long Island Sound. The Millstone site and the transmission line ROWs may cross or contain suitable habitat for some of these species. Given this possibility, Northeast Utilities has designed and implemented maintenance procedures for its transmission line rights-of-way that protect listed species and their habitats.

The staff has determined that license renewal for Millstone would have no effect on the Puritan tiger beetle, shortnose sturgeon, loggerhead, green turtle, leatherback turtle, Kemp's ridley, piping plover, right whale, finback whale, and the humpback whale. License renewal may affect, but is not likely to adversely affect, the bald eagle, the roseate tern, the New England cottontail, and the small whorled pogonia.

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Glen Allen, VA 23060-6711

Mr. William R. Watson, Jr.
Supervisor - License Renewal Project
Building 475/5
Millstone Power Station
Rope Ferry Road
Waterford, CT 06385

Millstone Power Station, Units 2 and 3

cc:
Robert A. Avena
Town Attorney for Waterford, CT
Kepple, Morgan & Avena, P.C.
Box 3A Anguilla Park
20 South Anguilla Road
Pawcatuck, CT 06379

Michael J. Amaral
U.S. Fish and Wildlife Service
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

January 5, 2005

Pao-Tsin Kuo
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Mr. Kuo:

We are in receipt of your biological assessment and request for concurrence for the proposed renewal of the Millstone Power Station, Units 2 and 3, Waterford, Connecticut. The following comments are provided in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543).

Based on information currently available to us, and the information contained within the biological assessment, the U.S. Fish and Wildlife Service concurs that the proposed action will have no effect on threatened puritan tiger beetles and piping plovers. We also concur that the proposed license is not likely to adversely affect the bald eagle, roseate tern and small whorled pogonia.

Further consultation with us under Section 7 of the Endangered Species Act is not required. This concludes our review of listed species and critical habitat in the project location and environs referenced above. No further Endangered Species Act coordination of this type is necessary for a period of one year from the date of this letter, unless additional information on listed or proposed species becomes available.

Thank you for your coordination. Please contact us at 603-223-2541 if we can be of further assistance. In the future, in order to expedite your reply, please direct any inquiries of this nature to this office at the above address.

Sincerely yours,

Michael J. Amaral

Michael J. Amaral
Endangered Species Specialist
New England Field Office

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

JAN 12 2005

Pao-Tsin Kuo
Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation
US Nuclear Regulatory Commission
MS T-11 F1
Washington, DC 20555

Re: Millstone Power Station Units 2 and 3 license renewal

Dear Mr. Kuo,

This is in response to your letter dated November 9, 2004 regarding the proposed renewal of the operating licenses for Units 2 and 3 of the Millstone Power Station for a period of 20 years. The Millstone Power Station is located on the north shore of Long Island Sound in the town of Waterford, CT. Included with your letter was a Biological Assessment (BA) which evaluates whether the proposed license renewal of the Millstone Power Station would have an adverse affect on listed species in Long Island Sound. The U.S. Nuclear Regulatory Commission (NRC) has made a preliminary determination that the proposed action will have no effect on listed species under the jurisdiction of the National Marine Fisheries Service (NOAA Fisheries).

In a letter dated September 21, 2004, NOAA Fisheries provided the NRC with a list of federally threatened and endangered species that are known to be seasonally present in the waters of Long Island Sound. Four species of federally threatened or endangered sea turtles may be found seasonally in the waters of Long Island Sound. Sea turtles are expected to be in the vicinity of the project area in warmer months, typically from May 1 to November 15. The sea turtles in Long Island waters are typically small juveniles with the most abundant being the federally threatened loggerhead (*Caretta caretta*) followed by the federally endangered Kemp's ridley (*Lepidochelys kempi*). The waters of Long Island Sound have also been found to be warm enough to support federally endangered green sea turtles (*Chelonia mydas*) from June through October. The three species of chelonid turtles found in the Northeast remain very briefly in open ocean waters, spending most of their time during the summer months in harbors and estuarine waters, such as those found in

Long Island Sound. Federally endangered leatherback sea turtles (*Dermochelys coriacea*) may be found in the waters of Long Island Sound during the warmer months as well.

Three species of federally endangered whales, North Atlantic right whales (*Eubalaena glacialis*), humpback whales (*Megaptera novaeangliae*), and fin whales (*Balaenoptera physalus*), may also be found seasonally in Northeast waters, although it rare that these species will travel into Long Island Sound. Federally endangered shortnose sturgeon (*Acipenser brevirostrum*) are know to occur in the Connecticut River which flows into Long Island Sound approximately 10 miles east of the Millstone site; however, shortnose sturgeon are not known to participate in coastal migrations and no shortnose sturgeon are likely to occur near the project site.

The entrainment and impingement of sea turtles has been documented at several nuclear power plants on the East Coast. The Millstone system withdraws water from Long Island Sound through intakes. Water withdrawn from Long Island Sound is filtered through trash and debris screens at a rate of 0.2 m/s^2. The debris screens are an effective mechanism to reduce the likelihood that aquatic organisms, including turtles, will be impinged or entrained on the intakes. The Millstone operators have been monitoring the intakes for over 20 years and no sea turtles have been documented to be impinged or entrained during that time. Based on the size of the screens, the rate of intake and the lack of sea turtle impingements or entrainments in the past, it is unlikely that sea turtles will be affected by the intakes through the term of the new license.

Water taken into the plant is pumped through a turbine condenser cooling system which causes the water temperature to increase. The heated water then surface discharges through a former granite quarry and flows out two cuts excavated from the bedrock into Long Island Sound. At full discharge flow the water temperature will have increased 9 to 14° C from its intake temperature. The National Pollutant Discharge Elimination System (NPDES) permit for the Millstone Power Station limits the discharge temperature to 40° C and limits the maximum increase in water temperature from intake to discharge to 18° C. Based on the volume of water in the discharge area, the ability for sea turtles to avoid the area of heated water, and the known tolerance of sea turtles to tropical water temperatures, it is unlikely that sea turtles will be affected by the discharge of heated water into Long Island Sound.

Based on the analysis above, NOAA Fisheries is able to concur with the NRC's determination that this project will have no effect on shortnose sturgeon, fin whales, humpback whales, or right whales. NOAA Fisheries is not able to concur with a no effect determination for the four species of sea turtles; however, based on the assessment above, it has been determined that the proposed action is not likely to adversely affect sea turtles. Therefore, no further consultation pursuant to section 7 of the ESA is required. Should project plans change or new information become

available that changes the basis for this determination, consultation should be reinitiated. Should you have any questions about these comments, please contact Sara McNulty at (978) 281-9328 ext. 6520.

Sincerely,

for Patricia A. Kurkul
Regional Administrator

Cc: Scida, F/NER3
Williams, GCNE
Rusanowsky, F/NER4

File code: Sec. 7, NRC Millstone Power Station

Appendix F

GEIS Environmental Issues Not Applicable to Millstone Power Station, Units 2 and 3

Appendix F

GEIS Environmental Issues Not Applicable to Millstone Power Station, Units 2 and 3

Table F-1 lists those environmental issues listed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996; 1999)[a] and 10 Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B, Table B-1, that are not applicable to Millstone Power Station, Units 2 and 3, because of plant or site characteristics.

Table F-1. GEIS Environmental Issues Not Applicable to Millstone Power Station, Units 2 and 3

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)			
Altered thermal stratification of lakes	1	4.2.1.2.3 4.4.2.2	Millstone does not discharge into a lake.
Temperature effects on sediment transport capacity	1	4.2.1.2.3 4.4.2.2	Millstone does not discharge into a small river.
Eutrophication	1	4.2.1.2.3 4.4.2.2	Millstone does not discharge into a lake.
Water-use conflicts (plants with cooling ponds or cooling towers using makeup water from a small river with low flow)	2	4.3.2.1 4.4.2.1	The Millstone cooling system does not use make-up water from a small river with low flow.
AQUATIC ECOLOGY (FOR ALL PLANTS)			
Premature emergence of aquatic insects	1	4.2.2.1.7 4.4.3	Aquatic insects are only present in freshwater environments.
AQUATIC ECOLOGY (FOR PLANTS WITH COOLING TOWER BASED HEAT DISSIPATION SYSTEMS)			
Entrainment of fish and shellfish in early life stages	1	4.3.3	This issue is related to heat-dissipation systems that are not installed at Millstone.
Impingement of fish and shellfish	1	4.3.3	This issue is related to heat-dissipation systems that are not installed at Millstone.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

Table F-1. (contd)

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
AQUATIC ECOLOGY (FOR PLANTS WITH COOLING TOWER BASED HEAT DISSIPATION SYSTEMS)			
Heat shock	1	4.3.3	This issue is related to heat-dissipation systems that are not installed at Millstone.
GROUND-WATER USE AND QUALITY			
Ground-water use conflicts (potable and service water, and dewatering; plants that use >100 gpm)	2	4.8.1.1 4.8.2.1	Millstone uses <100 gpm of groundwater.
Ground-water use conflicts (plants using cooling towers withdrawing makeup water from a small river)	2	4.8.1.3 4.4.2.1	This issue is related to heat-dissipation systems that are not installed at Millstone.
Ground-water use conflicts (Ranney wells)	2	4.8.1.4	Millstone does not have or use Ranney wells.
Ground-water quality degradation (Ranney wells)	1	4.8.2.2	Millstone does not have or use Ranney wells.
Ground-water quality degradation (cooling ponds in salt marshes)	1	4.8.3	Millstone does not use cooling ponds.
Ground-water quality degradation (cooling ponds at inland sites)	2	4.8.3	Millstone is not located at an inland site.
TERRESTRIAL RESOURCES			
Cooling tower impacts on crops and ornamental vegetation	1	4.3.4	This issue is related to a heat-dissipation system that is not installed at Millstone.
Cooling tower impacts on native plants	1	4.3.5.1	This issue is related to a heat-dissipation system that is not installed at Millstone.
Bird collisions with cooling towers	1	4.3.5.2	This issue is related to a heat-dissipation system that is not installed at Millstone.
Cooling pond impacts on terrestrial resources	1	4.4.4	This issue is related to a heat-dissipation system that is not installed at Millstone.

Table F-1. (contd)

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
	HUMAN HEALTH		
Microbial organisms (occupational health)(plants with cooling towers)	1	4.3.6	This issue is related to a heat-dissipation system that is not installed at Millstone.
Microbial organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river).	2	4.3.6	This issue is related to a heat-dissipation system that is not installed at Millstone.

F.1 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Main Report, Section 6.3, Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report.* NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

Appendix G

Connecticut State-Listed Terrestrial Species for Hartford, Middlesex, New London, and Tolland Counties with the Potential to Occur at the Millstone Site or Along Associated Transmission Line Rights-of-Way

Appendix G

Connecticut State-Listed Terrestrial Species for Hartford, Middlesex, New London, and Tolland Counties with the Potential to Occur at the Millstone Site or Along Associated Transmission Line Rights-of-Way

Table G-1. Connecticut State-Listed Terrestrial Species for Hartford, Middlesex, New London, and Tolland Counties with the Potential to Occur at the Millstone Site or Along Associated Transmission Line Rights-of-Way

Scientific Name	Common Name	State Status[a]
	AMPHIBIANS	
Ambystoma jeffersonianum	Jefferson salamander	SC
Ambystoma laterale	blue-spotted salamander	T
Gyrinophilus porphyriticus	northern spring salamander	T
Rana pipiens	northern leopard frog	SC
Scaphiopus holbrookii	eastern spadefoot	E
	BIRDS	
Aegolius acadius	northern saw-whet owl	SC
Ammodramus caudacutus	saltmarsh sharp-tailed sparrow	SC*
Ammodramus henslowii	Henslow's sparrow	SC*
Ammodramus maritimus	seaside sparrow	SC
Ammodramus savannarum	grasshopper sparrow	E
Anas discors	blue-winged teal	T
Asio flammeus	short-eared owl	T
Asio otus	long-eared owl	E
Bartramia longicauda	upland sandpiper	E
Botaurus lentiginosus	American bittern	E
Caprimulgus vociferus	whip-poor-will	SC
Cistothorus platensis	sedge wren	E
Corvus corax	common raven	SC

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	BIRDS	
Egretta caerulea	little blue heron	SC
Empidonax alnorum	alder flycatcher	SC
Eremophila alpestris	horned lark	E
Falco peregrinus	peregrine falcon	E
Falco sparverius	American kestrel	T
Gallinula chloropus	common moorhen	E
Gavia immer	common loon	SC
Haematopus palliatus	American oystercatcher	SC
Ixobrychus exilis	least bittern	T
Laterallus jamaicensis	black rail	E
Melanerpes erythrocephalus	red-headed woodpecker	E
Parula americana	northern parula	SC
Passerculus sandwichensis	savannah sparrow	SC
Passerculus sandwichensis ssp. *princeps*	Ipswich sparrow	SC
Plegadis falcinellus	glossy ibis	SC
Pooecetes gramineus	vesper sparrow	E
Progne subis	purple martin	T
Rallus elegans	king rail	E
Sterna hirundo	common tern	SC
Sturnella magna	eastern meadowlark	SC
Toxostoma rufum	brown thrasher	SC
Tyto alba	barn owl	E
Vermivora chrysoptera	golden-winged warbler	E
	INVERTEBRATES	
Acronicta lanceolaria	a noctuid moth	SC*
Apamea burgessi	a noctuid moth	SC
Apodrepanulatrix liberiaria	New Jersey tea inchworm	SC

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	INVERTEBRATES	
Callophrys henrici	Henry's elfin	SC
Callophrys irus	frosted elfin	T
Calopteryx dimidiata	sparkling jewelwing	SC
Catocala pretiosa	precious underwing moth	SC*
Chaetaglaea cerata	a noctuid moth	SC*
Cicindela formosa ssp. *generosa*	pine barrens tiger beetle	SC
Cicindela hirticollis	beach-dune tiger beetle	SC
Cicindela lepida	dune ghost tiger beetle	E
Cicindela purpurea	tiger beetle	SC*
Cicindela tranquebarica	dark-bellied tiger beetle	SC
Citheronia regalis	regal moth	SC*
Cordulegaster erronea	tiger spiketail	T
Cucullia speyeri	a noctuid moth	SC
Eacles imperialis ssp. *imperialis*	imperial moth	SC*
Enallagma doubldayi	Atlantic bluet	SC
Enallagma minusculum	little bluet	SC
Enallagma pictum	scarlet bluet	SC
Erynnis brizo	sleepy duskywing	T
Erynnis lucilius	columbine duskywing	E
Erynnis martialis	mottled duskywing	SC*
Erynnis persius ssp. *persius*	persius duskywing	E
Eucoptocnemis fimbriaris	a noctuid moth	SC
Euphyes bimacula	two-spotted skipper	T
Exyra rolandiana	pitcher plant moth	SC
Geopinus incrassatus	a ground beetle	SC
Gomphus adelphus	mustached clubtail dragonfly	T

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	INVERTEBRATES	
Gomphus descriptus	harpoon clubtail dragonfly	T
Gomphus fraternus	midland clubtail dragonfly	T
Gomphus vastus	cobra clubtail dragonfly	SC
Gomphus ventricosus	skillet clubtail dragonfly	SC
Grammia phyllira	phyllira tiger moth	SC*
Hetaerina americana	American rubyspot	SC
Hemileuca maia maia	buckmoth	E
Hybomitra frosti	a horse fly	T
Hybomitra typhus	a horse fly	SC
Ladona deplanata	blue corporal dragonfly	SC
Lepipolys perscripta	scribbled sallow	SC
Leptophlebia bradleyi	a mayfly	SC
Leucorrhinia glacialis	crimson-winged whiteface dragonfly	T
Lycaena epixanthe	bog copper	SC
Lycaena hyllus	bronze copper	SC
Merycomyia whitneyi	tabanid fly	SC
Mitoura hesseli	Hessel's hairstreak	E
Papaipema duovata	seaside goldenrod stem borer	SC
Paraleptophlebia assimilis	a mayfly	SC
Pomatiopsis lapidaria	slender walker	SC
Psectraglaea carnosa	pink sallow	T
Schinia spinosae	a noctuid moth	SC
Speyeria idalia	regal fritillary	SC*
Sphodros niger	purse-web spider	SC
Stylurus amnicola	riverine clubtail dragonfly	T
Tabanus fulvicallus	horse fly	SC
Williamsonia lintneri	banded bog skimmer	E

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	INVERTEBRATES	
Zale curema	a noctuid moth	SC
Zale obliqua	a noctuid moth	SC
Zale submedia	a noctuid moth	T
	MAMMALS	
Cryptotis parva	least shrew	E
Lasiurus borealis	eastern red bat	SC
Lasiurus cinereus	hoary bat	SC
Puma concolor ssp. *couguar*	eastern cougar	SC*
Synaptomys cooperi	southern bog lemming	SC
	PLANTS	
Acalypha virginica	Virginia copperleaf	SC
Agalinis acuta	sandplain gerardia	E
Agastache nepetoides	yellow giant hyssop	SC*
Agastache scrophularifolia	purple giant hyssop	E
Alopecurus aequalis	orange foxtail	T
Amelanchier sanguinea	roundleaf shadbush	E
Andromeda glaucophylla	bog rosemary	T
Angelica lucida	sea-coast angelica	E
Angelica venenosa	hairy angelica	SC*
Aplectrum hyemale	puttyroot	SC*
Arenaria glabra	smooth mountain sandwort	T
Arenaria macrophylla	large-leaved sandwort	E
Arethusa bulbosa	arethusa	SC*
Aristida longespica	needlegrass	SC
Aristida purpurascens	arrowfeather	SC
Aristolochia serpentaria	Virginia snakeroot	SC

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	PLANTS	
Asclepias purpurascens	purple milkweed	SC
Asclepias variegata	white milkweed	SC*
Asplenium montanum	mountain spleenwort	T
Asplenium ruta-muraria	wallrue spleenwort	T
Aster nemoralis	bog aster	E
Aster prenanthoides	crooked-stem aster	SC*
Aster radula	rough-leaved aster	E
Aster spectabilis	showy aster	T
Aster X blakei	Blake's aster	E
Aster X herveyi	Hervey's aster	SC
Bidens eatonii	Eaton's beggar-ticks	T
Blephilia ciliata	downy woodmint	SC*
Blephilia hirsuta	hairy woodmint	SC*
Calystegia spithamaea	low bindweed	SC*
Cardamine longii	Long's bitter-cress	SC*
Carex aestivalis	summer sedge	SC
Carex alata	broadwing sedge	E
Carex barrattii	Barratt's sedge	E
Carex bushii	sedge	SC
Carex buxbaumii	brown bog sedge	E
Carex collinsii	Collins' sedge	SC*
Carex crawfordii	Crawford sedge	SC*
Carex cumulata	clustered sedge	T
Carex davisii	Davis' sedge	E
Cares exilis	sedge	E
Carex hitchcockiana	Hitchcock's sedge	SC
Carex limosa	sedge	E

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	PLANTS	
Carex lupuliformis	false hop sedge	SC
Carex nigromarginata	black-edge sedge	SC*
Carex oligocarpa	eastern few-fruit sedge	SC
Carex oligosperma	few-seeded sedge	SC*
Carex polymorpha	variable sedge	E
Carex pseudocyperus	cyperus-like sedge	E
Carex squarrosa	sedge	SC
Carex sterilis	dioecious sedge	SC
Carex tuckermanii	Tuckerman sedge	SC
Carex typhina	sedge	SC
Castilleja coccinea	indian paintbrush	E
Cercis canadensis	eastern redbud	SC*
Chamaelirium luteum	devil's-bit	E
Chenopodium rubrum	coast blite	SC*
Chrysopsis falcata	sickle-leaf golden-aster	E
Cirsium horridulum	yellow thistle	E
Coeloglossum viride var. *virescens*	long-bracted green orchid	SC
Corollorhiza trifida	early coralroot	SC
Corydalis flavula	yellow corydalis	T
Crassula aquatica	pygmyweed	E
Cuphea viscosissima	blue waxweed	SC*
Cuscuta coryli	hazel dodder	SC*
Cypripedium parviflorum	yellow lady's-slipper	SC
Cypripedium reginae	showy lady's slipper	E
Deschampsia caespitosa	tufted hairygrass	SC
Desmodium glabellum	Dillen tick-trefoil	SC

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	PLANTS	
Desmodium humifusum	trailing tick-trefoil	SC
Desmodium sessilifolium	sessile-leaf tick-trefoil	SC*
Dicentra canadensis	squirrel-corn	T
Diplachne maritima	saltpond grass	E
Diplazium pycnocarpon	narrow-leaved glade fern	E
Draba reptans	whitlow-grass	SC
Dryopteris goldiana	Goldie's fern	SC
Echinodorus tenellus var. *parvulus*	bur-head	E
Eleocharis equisetoides	horse-tail spikerush	E
Eleocharis microcarpa var. *filiculmis*	spike-rush	SC*
Eleocharis quadrangulata var. *crassior*	spike-rush	E
Elymus trachycaulus var. *subsecundus*	slender wheatgrass	SC
Elymus wiegandii	Wiegand's wild rice	SC
Equisetum palustre	marsh horsetail	SC*
Equisetum pratense	meadow horsetail	E
Eriocarpon parkeri	Parker's pipewort	E
Eriophorum vaginatum var. *spissum*	hare's tail	T
Eupatorium album	white thoroughwort	E
Eupatorium aromaticum	small white snakeroot	E
Gaultheria hispidula	creeping snowberry	T
Gaylussacia dumosa var. *bigeloviana*	dwarf hucklberry	T
Geranium bicknellii	Bicknell northern crane's-bill	SC*
Gnaphalium purpureum	purple cudweed	SC*
Goodyera repens var. *ophioides*	dwarf rattlesnake plantain	SC*
Helianthemum propinquum	low frostweed	T
Hemicarpha micrantha	dwarf bulrush	E
Hottonia inflata	featherfoil	SC

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	PLANTS	
Houstonia longifolia	longleaf bluet	E
Hudsonia ericoides	golden-heather	E
Hudsonia tomentosa	false beach-heather	SC
Hydrastis canadensis	golden-seal	E
Hydrocotyle umbellata	water pennywort	E
Hydrocotyle verticillata	whorled pennywort	E
Hydrophyllum virginianum	Virginia waterleaf	SC
Hypericum adpressum	creeping St. John's wort	SC*
Hypericum pyramidatum	great St. John's wort	SC
Ilex glabra	ink-berry	T
Isanthus brachiatus	false pennyroyal	E
Juncus debilis	weak rush	SC*
Lachnanthes caroliana	Carolina redroot	E
Ledum groenlandica	Labrador tea	T
Liatris scariosa var. *novae-anglica*	blazing star	SC
Ligusticum scothicum	scotch lovage	E
Lilaeopsis chinensis	lilaeopsis	SC
Limosella subulata	mudwort	SC
Linnaea borealis var. *americana*	twinflower	E
Linum intercursum	sandplain flax	SC*
Linum sulcatum	yellow flax	SC
Liparis liliifolia	lily-leaved twayblade	E
Liquidambar styraciflua	sweet gum	SC
Ludwigia polycarpa	many-fruit false-loosestrife	SC*
Ludwigia sphaerocarpa	globe-fruited false-loosestrife	E
Lycopus amplectens	clasping-leaved water-horehound	SC

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	PLANTS	
Lygodium palmatum	climbing fern	SC
Malaxis unifolia	green adder's-mouth	E
Megalodonta beckii	water-marigold	T
Milium effusum	tall millet-grass	SC*
Mimulus alatus	winged monkey-flower	SC
Moneses uniflora	one-flower wintergreen	E
Myriophyllum pinnatum	cutleaf water-milfoil	E
Nuphar advena	large yellow pond lily	SC*
Nuphar microphylla	small yellow pond lily	SC
Nymphaea odorata var. *tuberosa*	water lily	SC*
Onosmodium viginianum	gravel-weed	E
Ophioglossum pusillum	adder's tongue	T
Opuntia humifusa	eastern prickly-pear	SC
Orontium aquaticum	golden club	SC
Oryzopsis pungens	slender mountain-ricegrass	SC
Oxalis violacea	violet wood-sorrel	SC
Panax quinquefolius	American ginseng	SC
Panicum amarum	panic grass	T
Panicum commonsianum	panic grass	SC
Panicum rigidulum var. *elongatum*	tall flat panic grass	SC*
Panicum scabriusculum	panic grass	E
Panicum xanthophysum	panic grass	SC*
Paronychia fastigiata	hairy forked chickweed	SC*
Paspalum laeve	field paspalum	E
Paspalum setaceum var. *psammophilum*	bead grass	SC*
Pedicularis lanceolata	swamp lousewort	T
Phaseolus polystachios var. *aquilonius*	wild kidney bean	SC*

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	PLANTS	
Pinus resinosa	red pine	E
Plantago virginica	hoary plantain	SC
Platanthera blephariglottis	white-fringed orchid	T
Platanthera ciliaris	yellow-fringed orchid	T
Platanthera dilatata	tall white bog orchid	SC*
Platanthera flava	pale green orchid	SC
Platanthera hookeri	Hooker orchid	SC*
Platanthera orbiculata	large roundleaf orchid	SC*
Podostemum ceratophyllum	threadfoot	SC
Polygala cruciata	field milkwort	SC
Polygala nuttallii	Nuttall's milkwort	E
Polymnia canadensis	small-flowered leafcup	E
Populus heterophylla	swamp cottonwood	E
Potamogeton confervoides	pondweed	SC*
Potemogeton pusillus var. *gemmiparus*	capillary pondweed	E
Potamogeton vaseyi	Vasey's pondweed	E
Potentilla arguta	tall cinquefoil	SC
Prunus alleghaniensis	Alleghany plum	SC*
Puccinellia langeana ssp. *alaskana*	goose grass	SC*
Pycnanthemum clinopodioides	basil mountain-mint	E
Pyrola secunda	one-sided pyrola	SC*
Ranunculus ambigens	water-plantain spearwort	E
Ranunculus cymbalaria	seaside crowfoot	SC*
Ranunculus pensylvanicus	bristly buttercup	SC*
Ranunculus sceleratus	cursed crowfoot	SC
Rhynchospora macrostachya	beaked rush	T

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	PLANTS	
Rhynchospora scirpoides	long-beaked baldrush	E
Ribes glandulosum	skunk currant	T
Ribes rotundifolium	wild currant	SC*
Ribes triste	swamp red currant	E
Rosa nitida	shining rose	SC
Rotala ramosior	toothcup	T
Rubus cuneifolius	sand bramble	SC
Rumex maritimus var. *fueginus*	sea-side dock	SC*
Sabatia stellaris	marsh pink	E
Sagittaria cuneata	waputo	SC*
Sagittaria subulata	arrowleaf	SC
Salix exigua	sandbar willow	T
Salix pedicellaris	bog willow	E
Salix petiolaris	slender willow	SC*
Saururus cernuus	lizard's tail	E
Scheuchzeria palustris	pod grass	E
Schizachne purpurascens	purple oat	SC
Schwalbea americana	chaffseed	SC*
Scirpus cylindricus	salt-marsh bulrush	SC
Scirpus hudsonianus	cotton bulrush	SC*
Scirpus longii	Long's bulrush	SC*
Scirpus paludosus var. *atlanticus*	bayonet grass	SC
Scirpus torreyi	Torrey's bulrush	T
Scleria pauciflora var. *caroliniana*	few-flowered nutrush	E
Scleria reticularis	reticulated nutrush	E
Scleria triglomerata	nutrush	E
Scutellaria integrifolia	hyssop skullcap	E

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	PLANTS	
Senecio pauperculus	ragwort	E
Senna hebecarpa	wild senna	SC
Silene stellata	starry campion	SC
Smilacina trifolia	three-leaved false Solomon's-seal	T
Solidago elliottii	Elliott goldenrod	SC
Solidago rugosa var. sphagnophila	early wrinkle-leaved goldenrod	SC*
Spergularia canadensis	Canada sand-spurry	T
Spiranthes tuberosa var. *grayi*	little ladies'-tresses	SC*
Sporobolus clandestinus	rough dropseed	E
Sporobolus neglectus	small dropseed	E
Stachys hyssopifolia	hyssop-leaf hedge-nettle	E
Stachys tenuifolia	smooth hedge-nettle	SC
Stellaria borealis	northern stitchwort	SC
Streptopus amplexifolius var. *americanus*	white mandarin	T
Thuja occidentalis	northern white cedar	T
Trichomanes intricatum	Appalachian gametophyte	SC
Triosteum angustifolium	narrow-leaved horse gentian	SC*
Triphora trianthophora	nodding pogonia	SC*
Trisetum spicatum var. *molle*	spiked false oats	SC*
Utricularia fibrosa	fibrous bladderwort	SC*
Utricularia resupinata	bladderwort	E
Uvularia grandiflora	large-flowered bellwort	E
Vaccinium myrtilloides	velvetleaf blueberry	SC*
Vaccinium vitis-idea var. *minus*	mountain cranberry	SC*
Valerianella radiata var. *fernaldii*	beaked corn-salad	SC*
Verbena simplex	narrow-leaved vervain	SC*

Table G-1. (contd)

Scientific Name	Common Name	State Status[a]
	PLANTS	
Vibernum nudum	possum haw	SC*
Viola canadensis	Canada violet	SC
Viola selkirkii	great-spurred violet	SC
Vitis novae-angliae	New England grape	SC
Waldsteinia fragarioides	barren strawberry	SC
Xyris montana	northern yellow-eyed grass	T
Xyris smalliana	Small's yellow-eyed grass	E
Zizia aptera	golden alexanders	E
	REPTILES	
Clemmys insculpta	wood turtle	SC
Crotalus horridus	timber rattlesnake	E
Eumeces fasciatus	five-lined skink	T
Heterodon platirhinus	eastern hognose snake	SC
Terrapene carolina	eastern box turtle	SC
Thamnophis sauritus	eastern ribbon snake	SC

(a) E=endangered, T = threatened, SC = species of concern, (*) = believed extirpated (CTDEP 2004)

Appendix H

NRC Staff Evaluation of Severe Accident Mitigation Alternatives (SAMAs) for Millstone Power Station, Unit 2, in Support of the License Renewal Application Review

Appendix H

NRC Staff Evaluation of Severe Accident Mitigation Alternatives (SAMAs) for Millstone Power Station, Unit 2, in Support of the License Renewal Application Review

H.1 Introduction

Dominion Nuclear Connecticut, Inc. (Dominion) submitted an assessment of SAMAs for Millstone Power Station, Unit 2 (MPS2) as part of the Environmental Report (ER) (Dominion 2004a). This assessment was based on the most recent MPS2 Probabilistic Risk Assessment (PRA) available at that time, a plant-specific off-site consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the MPS2 Individual Plant Examination (IPE) (NNECO 1993) and Individual Plant Examination of External Events (IPEEE) (NNECO 1995). In identifying and evaluating potential SAMAs, Dominion considered SAMA analyses performed for other operating plants, as well as industry and NRC documents that discuss potential plant improvements, such as NUREG-1560 (NRC 1997a). Dominion identified 196 potential SAMA candidates. This list was reduced to 44 unique SAMA candidates by eliminating SAMAs that were not applicable to MPS2 due to design differences, had already been implemented, or were related to a reactor coolant pump (RCP) seal dependency on charging pumps. Dominion assessed the costs and benefits associated with each of the remaining SAMAs and concluded in the ER that one of the candidate SAMAs evaluated would be cost-beneficial for MPS2.

Based on a review of the SAMA assessment, the NRC issued a request for additional information (RAI) to Dominion by letter dated June 22, 2004 (NRC 2004). Key questions concerned the following areas: peer reviews of the PRA, dominant risk contributors at MPS2 and the SAMAs that address these contributors, the mapping of Level 1 PRA results into the Level 2 analysis, the potential impact of external event initiators and uncertainties on the assessment results, detailed information on some specific candidate SAMAs, and consideration of additional SAMAs. Dominion submitted additional information by letter dated August 13, 2004 (Dominion 2004b) including, summaries of peer review comments and their impact on the SAMA analysis; importance measures and corresponding SAMA candidates; information regarding the Level 2 analysis; information related to the resolution of IPEEE outliers and the impact of external events in the risk analysis; an assessment of the impact of uncertainties; and additional information regarding specific SAMAs. Dominion's responses addressed the staff's concerns. As a result, Dominion identified one SAMA that is cost-beneficial, and a second SAMA that would be cost-beneficial if it can be accomplished via a severe accident management guideline, without a hardware modification.

An assessment of SAMAs for MPS2 is presented below.

H.2 Estimate of Risk for MPS2

Dominion's estimates of offsite risk at MPS2 are summarized in Section H.2.1. The summary is followed by the staff's review of Dominion's risk estimates in Section H.2.2.

H.2.1 Dominion's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the MPS2 Level 1 and 2 PRA model, which is an updated version of the IPE (NNECO 1993), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The identification of candidate SAMAs was based on Revision 2 of the PRA model, dated April 2001; the quantification of SAMA benefits was based on Revision 3, dated October 2002 (Dominion 2004b). The scope of the MPS2 PRA does not include external events.

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 7.17×10^{-5} per year. The CDF is based on the risk assessment for internally initiated events. Dominion did not include the contribution to risk from external events or internal flooding within the MPS2 risk estimates; however, it did account for the potential risk reduction benefits associated with external events by increasing the estimated benefits for internal events by 30 percent. This is discussed further in Sections H.4 and H.6.2.

The breakdown of CDF by initiating event is provided in Table H-1. As shown in this table, loss of coolant accidents (LOCAs), loss of cooling water to the primary side components (COOL) including service water (SW) and reactor building closed cooling water (RBCCW), loss of DC power, and transients including anticipated transients without scram (ATWS) are dominant contributors to the CDF. LOCAs are dominated by small-break LOCAs which make up about 36 percent of the total CDF. Bypass events [i.e., steam generator tube rupture (SGTR) and interfacing systems loss of coolant accident (ISLOCA)] contribute less than 4 percent to the total internal events CDF. In response to an RAI, Dominion estimated the contribution to CDF from internal floods to be approximately 2×10^{-7} per year (Dominion 2004b).

The Level 2 PRA model is based on the original Level 2 model of the IPE (NNECO 1993). The model has been revised to reflect modified plant damage states and new release categories. These revisions were made to make the plant damage states (PDSs) and release categories consistent with those used for Millstone Power Station, Unit 3 (MPS3). The result of this analysis is a matrix that transforms the PDS frequencies to the release category frequencies. The source terms for each release category (also termed the source term category) were obtained from the results of MAAP 3.0B analyses of the dominant core damage sequences in the IPE.

Table H-1. MPS2 Core Damage Frequency

Initiating Event or Accident Class	CDF (Per Year)	% Contribution to CDF
LOCA	2.66×10^{-5}	37.1
COOL (SW+Seal LOCA+ RBCCW)[a]	1.44×10^{-5}	20.1
Loss of DC power	1.03×10^{-5}	14.4
ATWS	8.68×10^{-6}	12.1
Transients	4.66×10^{-6}	6.5
SGTR	2.22×10^{-6}	3.1
Station blackout (SBO)	2.15×10^{-6}	3.0
Steamline and main feed line breaks	1.72×10^{-6}	2.4
Loss of offsite power (LOOP)	8.60×10^{-7}	1.2
ISLOCA	1.43×10^{-7}	0.2
Total CDF	7.17×10^{-5}	100

(a) COOL represents the loss of cooling water to the primary side components, leading to an eventual degradation of the reactor coolant pump seal integrity.

The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and public. Inputs for this analysis include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution within a 80 kilometer (km) (50-mile [mi]) radius for the year 2030, emergency response evacuation modeling, and economic data. The core radionuclide inventory is based on the generic pressurized water reactor (PWR) inventory provided in the MACCS2 manual, adjusted to represent the MPS2 power level of 2700 megawatts thermal (MW[t]). The magnitude of the onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC 1997b).

In the ER, Dominion estimated the dose to the population within 80 km (50 mi) of the MPS2 site to be approximately 0.174 person-sieverts (person-Sv) (17.4 person-roentgen equivalents man [person-rem]) per year. The breakdown of the total population dose by containment release mode is summarized in Table H-2. Intermediate containment failures dominate the population dose risk at MPS2, followed by SGTR and late-containment failures. Early-containment failures and ISLOCAs make relatively small contributions, each being less than 3 percent of the total. Containment isolation and basemat failures are each indicated to be zero contributors to risk. As indicated in the response to an RAI, these release modes are incorporated into other release modes with similar characteristics (Dominion 2004b).

Table H-2. Breakdown of Population Dose by Containment Release Mode (Unit 2)

Containment Release Mode	Population Dose (Person-rem[a] Per Year)	% Contribution
Intermediate failure	12.4	71
SGTR	2.5	14.4
Late failure	1.63	9.4
Early failure	0.48	3
ISLOCA	0.42	2.4
Containment isolation failure	0	0
Basemat failure	0	0
Total Population Dose	**17.4**	**100**

(a) One person-rem = 0.01 person-Sv

H.2.2 Review of Dominion's Risk Estimates

Dominion's determination of offsite risk at MPS2 is based on the following three major elements of analysis:

- the Level 1 and 2 risk models that form the bases for the 1993 IPE submittal (NNECO 1993) and the 1995 IPEEE submittal (NNECO 1995),
- the major modifications to the IPE models that have been incorporated in the MPS2 PRA, and
- the MACCS2 analyses performed to translate fission product source terms and release frequencies from the Level 2 PRA model into offsite consequence measures.

Each of these analyses was reviewed to determine the acceptability of Dominion's risk estimates for the SAMA analysis, as summarized below.

The staff's review of the MPS2 IPE is described in an NRC report dated May 21, 1996 (NRC 1996). Based on a review of the original IPE submittal, the staff concluded that IPE submittal met the intent of Generic Letter 88-20 (NRC 1988); that is, the IPE was of adequate quality to be used to look for design or operational vulnerabilities. The staff did, however,

identify a number of weaknesses in the IPE analysis. In response to an RAI, Dominion indicated that all of these weaknesses have been addressed in the PRA used for the SAMA analysis (Dominion 2004b).

A comparison of internal events risk profiles between the IPE and the PRA used in the SAMA analysis indicates an increase of approximately 3.8×10^{-5} per year in the total CDF (from 3.4×10^{-5} per year to 7.17×10^{-5} per year). The change is a net result of modeling changes and some minor plant design changes that have been implemented at MPS2 since the IPE. A summary listing of those changes that resulted in the greatest impact on the total CDF was provided in the ER and in response to RAIs (Dominion 2004a, 2004b), and include the following:

- added credit for passive ventilation in the intake structure
- updated the loss of normal power event frequency
- added new cross-tie to Unit 3 AC power sources to mitigate SBO conditions at Unit 2
- modified the total loss of cooling event tree by updating nodes for failure of the operator to trip the reactor coolant pumps and reactor coolant pump seal LOCA
- modified the AC power distribution logic by adding the MPS2 normal station service transformer as the power source (not previously modeled)
- modified the DC logic to (1) transfer to the loss of DC when emergency diesel generators and DC buses are not available, and (2) add a loss of DC bus A and B event as first event to be considered in the SBO event tree.

An additional change that has a significant impact on the CDF value is the truncation value used in the PRA model. For the PRA version used for the SAMA analysis, Dominion used a truncation value of 1.0×10^{-11}. In contrast, use of a truncation value of 2.0×10^{-9} (as used in previous versions of the PRA) would result in a CDF of about 5×10^{-5} per year. This alone would account for approximately half of the noted increase in CDF since the IPE.

The IPE CDF value for MPS2 is comparable to the CDF values reported in the IPEs for other Combustion Engineering (CE) PWR plants. Figure 11.6 of NUREG-1560 shows that the IPE-based total internal events CDF for CE PWRs ranges from 1×10^{-5} to 3×10^{-4} per year (NRC 1997a). It is recognized that other plants have reduced their values for CDF after the IPE submittals due to modeling and hardware changes. The current internal events CDF results for MPS2 remain comparable to the results for other plants of similar vintage and characteristics.

The staff considered the peer review performed for the MPS2 PRA, and the potential impact of the review findings on the SAMA evaluation. In response to an RAI, Dominion described the

external peer review, which was the Combustion Engineering Owners Group (CEOG) Peer Review of PRA Revision 0 performed in 1999 (Dominion 2004b). The review resulted in 25 Level A facts and observations (extremely important and necessary to address to ensure technical adequacy) and 59 Level B facts and observations (important and necessary to address but may be deferred until next PRA update). The majority of the recommendations from this review were addressed or reflected in Revision 3 of the MPS2 PRA. Seven of the Level A recommendations are yet to be resolved, while 25 of the Level B recommendations are yet to be resolved. Those Level A recommendations not yet incorporated are in the areas of accident sequence analysis, human reliability analysis, dependency analysis, and quantification. The Level B recommendations not yet incorporated affect all PRA elements. Dominion has reviewed all of the unresolved facts and observations and concluded that they have negligible impact on the SAMA analysis (Dominion 2004b). The staff has also reviewed Dominion's assessment of the impacts of the outstanding peer review comments and has come to the same conclusion.

Given that (1) the MPS2 PRA has been peer reviewed and the potential impact of the peer review findings on the SAMA evaluation has been assessed, (2) Dominion satisfactorily addressed staff questions regarding the PRA (Dominion 2004b), and (3) the CDF falls within the range of contemporary CDFs for CE plants, the staff concludes that the Level 1 PRA model is of sufficient quality to support the SAMA evaluation.

The licensee submitted an IPEEE in December 1995 (NNECO 1995), in response to Supplement 4 of Generic Letter 88-20. While the IPEEE submittal did not specifically state a criterion for identifying a vulnerability to severe accident risk in regard to the external events related to seismic, fire, or other external events, a number of outliers or "opportunities for safety enhancements" were identified. The current status of these outliers was provided by Dominion in response to a staff RAI. In the response, Dominion stated that of a total of 29 items, 21 were resolved prior to 2003. The remaining eight items were closed in August 2003 (Dominion 2004b). In a letter dated January 12, 2001, the staff concluded that the IPEEE submittal met the intent of Supplement 4 to Generic Letter 88-20, and that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities (NRC 2001).

The seismic portion of the IPEEE consisted of a 0.3g (the acceleration due to the gravitation force [g]) focused-scope seismic evaluation using the Electric Power Research Institute (EPRI) methodology for Seismic Margins Assessment (SMA). A total of 16 components were initially estimated to have high-confidence low-probability of failure (HCLPF) capacities less than the review level earthquake peak ground acceleration of 0.3g. The lowest of these were included in the list of outliers to be resolved. The actions taken by the licensee to resolve seismic outliers included modification of the RBCCW and chilled water surge tanks supports, and modification to anchorage of battery racks. Other items were resolved by verifying component adequacy by

calculation or by correcting housekeeping problems. After resolution of these outliers, three components remained with HCLPF values less than the 0.3g review level earthquake: the turbine building housing the auxiliary feedwater (AFW) pumps (0.25g), the 125 VDC vital bus 201B (0.26g), and the RBCCW heat exchangers (0.29g). Dominion concluded that because of adequate seismic margins and the complexity associated with increasing the seismic capacity of a structure, no cost-effective SAMAs related to seismic events could be identified (Dominion 2004b). The staff agrees that it is unlikely that cost-effective SAMAs that address seismic vulnerabilities will exist. This is due to high cost of structural modifications compared to the benefits expected.

The MPS2 IPEEE does not provide numerical estimates of the CDF contributions from seismic initiators. Section F.2.4 of the ER indicates that the seismic CDF is 9.1×10^{-6} per year. Since the SMA does not result in a numerical value, the staff asked Dominion to provide the basis for the seismic CDF value given in the ER (NRC 2004). In response, Dominion indicated that the value used is the seismic CDF for Millstone Power Station, Unit 3 (MPS3) obtained from the MPS3 seismic PRA. The staff notes that for MPS3 all of the plant components or structures whose failure would significantly impact CDF have HCLPF values equal to or greater than the review level earthquake acceleration of 0.3g, whereas MPS2 has three components/structures with HCLPF values that are below 0.3g. This would indicate that the seismic CDF for MPS2 may be greater than that for MPS3.

Even though the MPS2 seismic CDF may be larger than that used to estimate the added benefit of SAMA candidates due to their impact on seismic risk, the staff believes that the seismic CDF would remain a relatively small contributor to the total CDF. This is due to the small contribution that low-magnitude earthquakes make to the CDF. The impact of low-magnitude earthquakes (in the range of 0.1 to 0.3 g) is principally in causing initiating events and for a LOOP reducing the likelihood of offsite power recovery. The frequency of these seismic initiating events is several orders of magnitude less than that due to random failures. Even a station blackout following a seismic LOOP has a frequency considerably less than that due to internal events. For higher-magnitude earthquakes, the impact of structural failures starts to become more important. However, as indicated above, SAMAs to mitigate these risk contributors are not expected to be cost effective.

The licensee's IPEEE fire analysis was based on EPRI's Fire Induced Vulnerability Evaluation methodology. This methodology employs a graduated focus on the most important fire zones using qualitative and quantitative screening criteria. The fire zones or compartments were subjected to at least two screening phases. In the first phase, a zone was screened out if a fire could not cause an initiating event and if the zone contained no equipment or cables needed to mitigate an initiating event. In the second-phase screening, three quantitative criteria were used: (1) a zone is screened out if the CDF is less than 1×10^{-6} per year from evaluating the plant model assuming all equipment in the zone is lost, (2) a zone is screened out if contains a single train of safety equipment and the fire induced unavailability is small compared to that due

to internal events, and (3) a zone is screened out if the effect of a fire is similar to but less severe than that in another analyzed zone. Of a total of 87 fire zones, 13 zones comprising five fire areas were not screened out and were subjected to a more detailed quantitative analysis. These areas are as follows:

Fire Area	Description	CDF (per year)
AUXB-1	auxiliary building	2.76×10^{-6}
A-24	cable vault	2.83×10^{-7}
A-25	main control room	6.57×10^{-7}
I-1A	intake structure pump room	9.66×10^{-7}
TB	turbine building general areas	1.63×10^{-6}

The fire CDF for MPS2 is approximately 6.3×10^{-6} per year or about nine percent of the MPS2 internal events CDF.

In an RAI, the staff asked Dominion to explain, for each important fire area, what measures were taken to further reduce risk, and explain why these CDFs cannot be further reduced in a cost-effective manner (NRC 2004). For each area, Dominion provided a discussion of the major fire contributors assumed in the analysis and the existing plant features to address fire events. Dominion identified several improvements that have been implemented to address fire-related issues and confirmed that all fire-related plant outliers identified in IPEEE were implemented prior to the SAMA analysis. Dominion also discussed the potential for further cost-effective hardware changes to address the fire-related matters listed above, including improvements to detection systems, enhancements to suppression capabilities, and changes that would improve cable separation and train separation (Dominion 2004b). Dominion concluded that no further modifications would be cost-effective for any of the fire areas.

The staff notes that although additional SAMAs to reduce the fire risk contributors might be viable, given the low level of risk from fires and the improvements that have already been implemented, it is unlikely that further modifications would both substantially reduce risk and remain cost-beneficial.

The risk associated with other external events at MPS2 is small. While the CDFs due to high winds, floods and other events were not estimated since they were screened out using the NUREG-1407 approach (NRC 1991), a number of possible enhancements were identified in the IPEEE. These enhancements, primarily related to high winds and external flooding, have all been resolved (NRC 2001).

In the SAMA analysis, Dominion accounted for the additional risk contribution due to external events by increasing the benefit derived from the internal events model by 30 percent. This was determined by summing the following CDF contributions:

- Fire 6.3×10^{-6} per year
- Internal flooding 0.2×10^{-6} per year
- Seismic 9.1×10^{-6} per year

The fire contribution is discussed above. The internal flood contribution is based on the IPE analysis, but has subsequently been dropped from the internal events model. The total external events CDF from the above is 1.6×10^{-5} per year, or approximately 22 percent of the CDF due to internal events. This was rounded up to 30 percent for the SAMA analysis.

The MPS2 Level 2 PRA analysis is based on the IPE. The IPE results were transformed to reflect new plant damage state and release category definitions. This process is described in Section F.2.3 of the ER (Dominion 2004a), and further clarified in response to RAIs (Dominion 2004b, 2004c). The resulting plant damage state to release category transformation matrix and release category frequencies are provided in Tables F.2-4 and F.2-6 of the ER, respectively (Dominion 2004a). The release fractions for each release category were obtained from MAAP 3.0B analysis for the dominant sequences in the IPE and are provided in Table F.1-2 of the ER (Dominion 2004a). In response to an RAI concerning the use of IPE dominant sequences to determine the release fractions used in the SAMA analysis, Dominion provided a discussion and a comparison of the plant damage states and release categories for the IPE and SAMA analyses (Dominion 2004b). The staff reviewed Dominion's source term estimates for the major release categories and found the release fractions to be within the range of the release fractions for similar plants. Dominion also provided the results of several sensitivity studies relative to the source term and release characteristics including doubling the plume release height, doubling the duration of source term release time, setting source term for M9 and M11 (late and basemat failures with sprays) equal to M10 (basemat failure without sprays), and using the MPS3 data for release category M1A (ISLOCA sequence). The results showed that these parameter variations had only a minor impact (less than 10 percent) on the estimated dollar benefits for the candidate SAMAs. The staff concludes that the process used for determining the release category frequencies and source terms is reasonable and appropriate for the purposes of the SAMA analysis.

As discussed previously, the fission product inventory used in the consequence analysis is based on a fission product inventory scaled from generic information. In response to an RAI concerning the impact of current and future fuel management practices, Dominion described a conservative bounding analysis of core fission product inventory considering a range of enrichments and burnups (Dominion 2004b). Using this inventory would result in a 22-percent increase in total benefit from eliminating all risk. Using realistic mid-life or average conditions

would result in a smaller increase in the maximum benefit. The staff concludes that the scaling based on the plant-specific power level yields sufficiently accurate and reasonable results for the dose assessment.

The staff reviewed the process used by Dominion to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (essentially a Level 3 PRA). This included consideration of the major input assumptions used in the offsite consequence analyses. The MACCS2 code was utilized to estimate offsite consequences. Plant-specific input to the code includes the source terms for each release category and the MPS2 reactor core radionuclide inventory (both discussed above), site-specific meteorological data, projected population distribution within a 80 km (50 mile) radius for the year 2030, and emergency evacuation modeling. This information is provided in Appendix F to the ER (Dominion, 2004a).

Dominion used site-specific meteorological data processed from hourly measurements for the 2000 calendar year as input to the MACCS2 code. The hourly data (wind direction, wind speed, and stability class) were collected from the onsite meteorological tower. Precipitation data were recorded at the Green Airport near Providence, Rhode Island, the closest weather station to Millstone. Morning and afternoon mixing height values were obtained from the National Climatic Data Center. The applicant also considered the impact on SAMA benefits of using meteorological data for 1998 and 1999. The results of these sensitivity cases showed that the benefits increased by an average of about five percent. The staff considers the use of the 2000 data in the base case to be reasonable.

The population distribution the applicant used as input to the MACCS2 analysis was estimated for the year 2030, based primarily on SECPOP90 (NRC 1997c). U.S. Census Bureau Year 2000 population data, projected to year 2030, was then used to update the SECPOP90 population data (Dominion 2004a). The staff questioned the difference between the use of SECPOP90 and SECPOP2000, and what the impact would be if the latter was used. In response, Dominion noted that the expected impact of using SECPOP2000 would be negligible since census data from 2000 were used to update the SECPOP90 file. The staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA evaluation.

The emergency evacuation model was modeled as a single evacuation zone extending out 16 km (10 mi) from the plant. It was assumed that 100 percent of the population would move at an average speed of approximately 1.49 meters per second with a delayed start time of 7200 seconds from the offsite alarm reference time point (Dominion 2004a). Dominion performed sensitivity studies exploring the impact of the fraction of population that evacuates and the evacuation speed. The results demonstrated that the total dose and economic cost

results are insensitive to these parameters (Dominion 2004a). The staff concludes that the evacuation assumptions and analysis are reasonable and acceptable for the purposes of the SAMA evaluation.

Much of the site-specific economic data was provided from SECPOP90 (NRC 1997c) by specifying the data for counties surrounding the plant to a distance of 50 miles. The SECPOP90 input file was updated to 2001 using cost of living and other data from the Bureau of the Census and the Department of Agriculture (Dominion 2004a). The agricultural economic data were updated using available data from the 1997 Census of Agriculture (USDA 1998).

The staff concludes that the methodology used by Dominion to estimate the offsite consequences for MPS2 provides an acceptable basis from which to proceed with an assessment of risk reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDF and offsite doses reported by Dominion.

H.3 Potential Plant Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by Dominion are discussed in this section.

H.3.1 Process for Identifying Potential Plant Improvements

Dominion's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- review of the most significant basic events from the MPS2 PRA Model, Rev. 2 (April 2001),
- review of items not already evaluated and/or implemented during the IPE and IPEEE,
- review of SAMA analyses submitted in support of original licensing and license renewal activities for other operating nuclear power plants, and
- review of other NRC and industry documentation discussing potential plant improvements.

Based on this process, an initial set of 196 candidate SAMAs was identified. In Phase 1 of the evaluation, Dominion performed a qualitative screening of the initial list of SAMAs and eliminated SAMAs from further consideration using the following criteria:

- the SAMA is not applicable at MPS2,
- the SAMA has already been implemented at MPS2, or the MPS2 design meets the intent of the SAMA, or

- the SAMA is related to a RCP seal vulnerability stemming from charging pump dependency on component cooling water (CCW). (MPS2 does not have this vulnerability because it relies on the RBCCW system rather than CCW for RCP seal cooling.)

Based on this screening, 152 SAMAs were eliminated leaving 44 for further evaluation. Of the SAMAs eliminated, 53 were eliminated because they were not applicable, 91 were eliminated because they already had been implemented, five were eliminated because they were related to RCP seal vulnerability, and three were similar to and combined with other SAMAs. A cost estimate was prepared for each of the 44 remaining candidates to focus on those that had a possibility of having a net positive benefit. To account for the potential impact of external events, the estimated benefits based on internal events were multiplied by a factor of 1.3 for all SAMAs except those related to ISLOCA and SGTR-initiated events.

Of the 44 SAMAs evaluated, one was identified as potentially cost-beneficial. Other SAMAs were evaluated and subsequently eliminated, as described in Sections H.4 and H.6.1 below.

H.3.2 Review of Dominion's Process

Dominion's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events. The initial list of SAMAs generally addressed the accident categories that are dominant CDF contributors or issues that tend to have a large impact on a number of accident sequences at MPS2.

The preliminary review of Dominion's SAMA identification process raised some concerns regarding the completeness of the set of SAMAs identified and the inclusion of plant-specific risk contributors. The staff requested additional information regarding the top 30 cut sets and certain sequences (NRC 2004). In response to the RAI, Dominion provided a listing of the top contributors to risk, the associated plant damage state, and a cross-reference between the top contributors to risk from a later version of the PRA and the SAMAs that addressed those risk contributors (Dominion 2004b).

The staff noted that Dominion based the SAMA identification process on PRA Revision 2 (dated April 2001) and the SAMA quantification on Revision 3 (dated October 2002). The staff questioned Dominion regarding the impact on the SAMA identification process if the later version of the PRA was used to identify potential SAMAs (NRC 2004). In response, Dominion reassessed the SAMA identification process considering the later PRA revision. The basic events not included in the initial Unit 2 PRA importance list were identified. Those events with a risk reduction worth greater than or equal to 1.005 from the more recent PRA model were specifically evaluated. These events were compared to the SAMA list to determine which events were already addressed by a SAMA. Dominion determined that all of the additional basic events map to previously identified SAMAs. As a result, no new SAMAs were created

(Dominion 2004c). Based on these additional assessments, Dominion concluded that the set of 196 SAMAs evaluated in the ER addresses the major contributors to CDF and offsite dose, and that the review of the top risk contributors does not reveal any new SAMAs.

The staff questioned Dominion regarding use of the second screening criterion (i.e., screening out a SAMA on the basis that it has already been implemented at MPS2) to eliminate SAMAs that were identified based on review of the PRA (NRC 2004). In response, Dominion provided qualitative or quantitative details on the plant-specific SAMAs that were screened using this criterion (SAMAs 161, 162, 163, 164, 167, 168, 169, 171, 177, 178, 180, 181, 188, and 196). None of these SAMAs were determined to be cost-beneficial based on this further evaluation.

The staff questioned Dominion about lower-cost alternatives to some of the SAMAs evaluated, including the use of portable battery chargers and a direct-drive diesel AFW pump (NRC 2004). In response, Dominion identified several lower-cost alternatives, all of which are covered by an existing procedure or severe accident management guideline (SAMG), or could be instituted following evaluation and guidance by the Technical Support Center (Dominion 2004b). This is discussed further in Section H.6.2.

The staff also questioned Dominion about several other candidate SAMAs that were found to be potentially cost-beneficial at another CE plant but not addressed by MPS2 (NRC 2004). In response, Dominion provided an evaluation of the applicability and/or costs and benefits for these SAMAs at MPS2. Based on this assessment, all of the SAMAs were dismissed except one involving adding a capability to flash the field on the emergency diesel generator to enhance SBO event recovery (Dominion 2004b). This is discussed further in Section H.6.2.

The staff notes that the set of SAMAs submitted is not all inclusive, since additional, possibly even less expensive, design alternatives can always be postulated. However, the staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least-expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The staff concludes that Dominion used a systematic and comprehensive process for identifying potential plant improvements for MPS2, and that the set of potential plant improvements identified by Dominion is reasonably comprehensive and, therefore, acceptable. This search included reviewing insights from the IPE and IPEEE and other plant-specific studies, reviewing plant improvements considered in previous SAMA analyses, and using the knowledge and experience of its PRA personnel. While explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for seismic events and the absence of external event vulnerabilities reasonably justifies examining primarily the internal events risk results for this purpose.

H.4 Risk Reduction Potential of Plant Improvements

Dominion evaluated the risk-reduction potential of the 44 remaining SAMAs that were applicable to MPS2. A majority of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement. Such bounding calculations overestimate the benefit and are conservative.

Dominion estimated the potential benefits for each SAMA by generating a revised set of plant damage state frequencies. Using these revised frequencies, a revised Level 3 (dollars averted) calculation was performed. The benefit was calculated using the fault trees, event trees, and databases from Revision 3 of the MPS2 PRA. The assumptions made to evaluate the benefit were provided in response to an RAI (Dominion 2004b, 2004c). Table H-3 lists the assumptions considered to estimate the risk reduction for each of the evaluated SAMAs, the estimated risk reduction in terms of percent reduction in CDF and population dose, and the estimated total benefit (present value) of the averted risk (including the 1.3 multiplier to account for benefits in external events). The determination of the benefits for the various SAMAs is further discussed in Section H.6.

The staff has reviewed Dominion's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on Dominion's risk reduction estimates. The estimated risk reduction for several of the SAMAs was negligible or zero. In these instances, the SAMA either affects sequences or phenomena that do not contribute to risk at MPS2, or represents an ineffective plant improvement. As such, a minimal impact on risk is not unreasonable in those cases.

H.5 Cost Impacts of Candidate Plant Improvements

Dominion personnel experienced in estimating the cost of performing work at a nuclear plant estimated the costs of implementing the 44 candidate SAMAs. For some of the SAMAs considered, the cost estimates were sufficiently greater than the benefits calculated such that it was not necessary to perform a detailed cost estimate. Cost estimates typically included procedures, engineering analysis, training, and documentation, in addition to any hardware.

The staff reviewed the bases for the applicant's cost estimates (presented in Section F.3 of Appendix F to the ER). For certain improvements, the staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as

Table H-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 2

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
3 - Enhance loss of RBCCW procedure to ensure cool down of reactor coolant system (RCS) prior to seal LOCA	**Set RCP seal failure and loss of the RBCCW system to zero (This SAMA is bolded because it was determined to be cost-beneficial)**	**7.8**	**4.9**	**173,300**	**100,000**
8 - Eliminate RCP thermal barrier dependence on RBCCW such that loss of RBCCW does not result directly in core damage	Set loss of the RBCCW system to zero	6.9	4.6	155,500	5,000,000
10 - Create an independent RCP seal cooling system, with dedicated diesel	Eliminate the need for RCP cooling from the fault tree	6	3.9	135,400	6,000,000
11 - Create an independent RCP seal cooling system, without dedicated diesel	Same as SAMA #10	6	3.9	135,400	5,000,000
22 - Improve ability to cool residual heat removal heat exchangers	Set RBCCW heat exchanger failures to zero	0.3	0.3	7,300	2,500,000
34 - Install a containment vent large enough to remove ATWS decay heat	Set the electrical and mechanical reactor trip probabilities to zero	9.9	4.0	204,300	10,000,000
35 - Install a filtered containment vent to remove decay heat	Set the containment spray component failures to zero	16.2	16.0	414,300	12,000,000
36 - Install an unfiltered hardened containment vent	Same as SAMA #35	16.2	16.0	414,300	10,000,000

Table H-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 2 (Cont.)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
43 - Create a reactor cavity flooding system	Re-bin intermediate and late containment failures without sprays into corresponding release categories with sprays	0	16.4	84,700	18,000,000
44 - Create other options for reactor cavity flooding	Same as SAMA #43	0	16.4	84,700	18,000,000
75 - Create a water backup for diesel cooling	Set loss of emergency diesel generator (EDG) 'A' and 'B' and common cause failure (CCF) of EDG 'A' and 'B' to zero	1.5	2.8	44,600	10,000,000
77 - Provide a connection to alternate offsite power source (the nearby dam)	Remove cutsets containing loss of the Unit 3 cross-tie and grid and weather related losses of normal power from the base case. Set Unit 3 cross-tie and grid and weather related initiators to zero	8.3	13.9	234,900	6,000,000
81 - Install a fast acting motor generator output breaker	Set 125 VDC Buses 201A and 201B initiators to zero	1.0	1.7	29,200	3,000,000
87 - Replace steam generators with new design	Set steam generator tube rupture initiating event frequency to zero	3	12.7	126,900	200,000,000
93 - Install additional instrumentation and inspection to prevent ISLOCA sequences	Set the ISLOCA containment release category frequency to zero	0.2	2.4	22,100	12,000,000
94 - Increase frequency of valve leakage testing	Same as SAMA #93	0.2	2.4	22,100	2,000,000
99 - Ensure all ISLOCA releases are scrubbed	Same as SAMA #93	0.2	2.4	22,100	4,000,000

Table H-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 2 (Cont.)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
100 - Add redundant and diverse limit switch to each containment isolation valve	Same as SAMA #93	0.2	2.4	28,700	18,000,000
123 - Provide capability for diesel-driven, low pressure vessel makeup	Set failure of the low pressure safety injection (LPSI) pumps and CCF of the LPSI pumps to zero	0	0	0	7,500,000
124/125 - Provide an additional high pressure injection pump with independent diesel	Set failure of the high pressure safety injection (HPSI) pumps and CCF of the HPSI pumps to zero	10.5	13.0	286,100	10,000,000
127 - Implement a reactor water storage tank (RWST) makeup procedure	Set probability of RWST rupture and RWST unavailability to zero	0.2	0.5	7,400	50,000
150 - Provide an additional instrumentation & control system (e.g. ATWS Mitigation System Actuation Circuitry)	Set electrical reactor trip and turbine trip to zero	8.7	3.5	177,900	600,000
159 - Install turbine-drive AFW pump	Set failure of the turbine driven AFW pumps to zero	8.0	5.1	178,100	12,000,000

Table H-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 2 (Cont.)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
165 - Install independent air-operated valve (AOV) around existing RBCCW/engineered safeguards feature room service (ESFRS) AOV in "A" train to improve reliability of engineered safety feature room cooler	Set failure of RBCCW/ESFRS AOV 2-RB-68.1A to open to zero	0.2	0.3	4,900	4,000,000
166 - Install additional motor-driven AFW pump	Set failure of the motor driven AFW pumps 'A' and 'B' to zero	2.2	1.1	47,400	12,000,000
170 - Install redundant parallel containment sump motor-operated valve (MOV) to provide additional flow path during containment swapover in recirculation	Set failure of MOV 2-CS-16.1A to open to zero	6.0	5.3	146,900	2,000,000
172 - Add a redundant 125 VDC bus	Set loss of 125 VDC buses 201A and 201B initiators and bus faults to zero	0.1	0.3	4,100	5,000,000
173 - Install diverse valve around existing service water AOV in each train to improve reliability of cooling water supply to RBCCW heat exchangers	Set failure of AOVs 2-SW-8.1A/B/C to open and CCF to open to zero	8.0	4.6	175,000	1,000,000
174 - Install additional AOV in series with existing AOV in each train to improve isolation of RBCCW supply to non-essential Spent Fuel Pool heat exchanger	Set failure of AOV 2-RB-8.1A to close to zero	3.4	2.1	74,900	2,000,000

Table H-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 2 (Cont.)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
176 - Install additional AOV around existing service water AOV in "A" train to improve reliability of cooling water supply to RBCCW heat exchanger	Set failure of AOV 2-SW-8.1A to open to zero	2.2	1.3	48,600	3,000,000
179 - Automate RCP trip circuitry on loss of seal cooling	Set failure of operator to trip RCPs on loss of thermal barrier cooling to zero	6.0	3.9	135,400	3,000,000
182 - Automate the start and alignment of the RBCCW pump	Set failure of operator to align stand-by RBCCW pump to zero	0	0	0	1,000,000
183 - Automate isolation feature of faulted steam generator	Set failure of operator to isolate faulted steam generator to zero	1.3	0.6	27,400	5,000,000
184 - Install redundant AFW regulating valve following regulating valve fail to open	Set failure of operator to open AFW regulating bypass valve on failure of AFW regulating valve to open to zero	0.7	0.4	15,900	2,000,000
185 - Install redundant ESFRS fan	Eliminate the need for ESFRS fan F-15B from the fault tree and set the unavailability of ESFRS fans F-15A and F-15B as well as their CCF to zero	0.2	0.3	4,900	450,000
186 - Install diverse strainers L-1A, B, C to all three SW pump discharge lines to prevent CCF	Set failure of CCF of all 3 SW pump strainer initiator as well as CCF of strainers to operate to zero	0.5	0.7	13,200	2,000,000
187 - Automate start capability of Terry turbine	Set failure of operator to start the Terry turbine to zero	0.2	0.3	4,500	1,500,000
189 - Automate emergency boration of RCS	Set the electrical and mechanical reactor trip probabilities to zero	0.9	0.5	18,700	2,000,000

Table H-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 2 (Cont.)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
190 - Install redundant parallel valve in charging pump suction line to RWST	Set failure of the RWST isolation valve AOV 2-CH-192 to open to zero	1.0	0.5	22,100	1,000,000
192 - Install additional MOV on volume control tank outlet line similar to MOV-CH-501 for closure to assure boric acid flow to charging pump	Set all failures relating to MOV 2-CH-501 to close to zero	0.7	0.4	15,500	2,000,000
193 - Install additional AFW bypass line with diverse check valves and regulating valves similar to check valves 2-FW-12A and 12B and regulating valves 2-FW-43A and 43B to steam generators	Set failure of the AOVs 2-FW-43A/B to open, their CCF to open, their air accumulators to operate, as well as CCF of CVs 2-FW-12A/B to open to zero	1.0	0.5	21,700	1,000,000
195 - Install an MOV around existing RBCCW/ESFRS AOV in each train to improve reliability of ESF room coolers	Set failures of AOVs 2-RB-68.1A/B to open and CCF to open to zero	0.4	0.7	11,600	500,000

part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. The cost estimates provided were in the form of ranges. For purposes of evaluating specific SAMAs, the staff selected the low end values from the range to represent the costs. For some SAMAs, the costs appeared to be overestimated. Therefore, the staff asked the applicant to justify the costs for those SAMAs that had significant benefits (NRC 2004). In response to the staff's request, Dominion provided a discussion of the components and activities that were considered in estimating the costs of those SAMAs for which the benefit was determined to be $50,000 or more. The discussion included a description of the modification, if any procedure changes and training would be required, and if any new instrumentation and maintenance would be required (Dominion 2004b). The staff reviewed the costs and subsequent explanations and found them to be reasonable and generally consistent with estimates provided in support of other plants' analyses.

The staff concludes that the cost estimates provided by Dominion are sufficient and adequate for use in the SAMA evaluation.

H.6 Cost-Benefit Comparison

Dominion's cost-benefit analysis and the staff's review are described in the following sections.

H.6.1 Dominion Evaluation

The methodology used by Dominion was based primarily on NRC's guidance for performing cost-benefit analysis, i.e., NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997b). The guidance involves determining the net value for each SAMA according to the following formula:

$$\text{Net Value} = (\text{APE} + \text{AOC} + \text{AOE} + \text{AOSC}) - \text{COE}$$

where,

APE = present value of averted public exposure ($)
AOC = present value of averted offsite property damage costs ($)
AOE = present value of averted occupational exposure costs ($)
AOSC = present value of averted onsite costs ($)
COE = cost of enhancement ($).

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. Dominion's derivation of each of the associated costs is summarized below.

Averted Public Exposure (APE) Costs

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δperson-rem/year)
x monetary equivalent of unit dose ($2,000 per person-rem)
x present value conversion factor (10.76 based on a 20-year period with a 7-percent discount rate).

As stated in NUREG/BR-0184 (NRC 1997b), it is important to note that the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, Dominion calculated an APE of approximately $375,000 for the 20-year license renewal period, which assumes elimination of all severe accidents.

Averted Offsite Property Damage Costs (AOC)

The AOCs were calculated using the following formula:

AOC = Annual CDF reduction
x offsite economic costs associated with a severe accident (on a per-event basis)
x present value conversion factor.

For the purposes of initial screening, which assumes all severe accidents are eliminated, Dominion calculated an annual offsite economic risk of about $13,700 based on the Level 3 risk analysis. This results in a discounted value of approximately $147,500 for the 20-year license renewal period.

Averted Occupational Exposure (AOE) Costs

The AOE costs were calculated using the following formula:

AOE = Annual CDF reduction
x occupational exposure per core damage event
x monetary equivalent of unit dose
x present value conversion factor.

Dominion derived the values for averted occupational exposure from information provided in Section 5.7.3 of the regulatory analysis handbook (NRC 1997b). Best estimate values provided

for immediate occupational dose (3300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $2,000 per person-rem, a real discount rate of 7 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes all severe accidents are eliminated, Dominion calculated an AOE of approximately $27,300 for the 20-year license renewal period.

Averted Onsite Costs (AOSC)

Averted onsite costs (AOSC) include averted cleanup and decontamination costs and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. Dominion derived the values for AOSC based on information provided in Section 5.7.6 of the regulatory analysis handbook (NRC 1997b).

Dominion divided this cost element into two parts — the Onsite Cleanup and Decontamination Cost, also commonly referred to as averted cleanup and decontamination costs, and the replacement power cost.

Averted cleanup and decontamination costs (ACC) were calculated using the following formula:

ACC = Annual CDF reduction
x present value of cleanup costs per core damage event
x present value conversion factor.

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in the regulatory analysis handbook to be $1.5 billion (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension. For the purposes of initial screening, which assumes all severe accidents are eliminated, Dominion calculated an ACC of approximately $831,700 for the 20-year license renewal period.

Long-term replacement power costs (RPC) were calculated using the following formula:

RPC = Annual CDF reduction
x present value of replacement power for a single event
x factor to account for remaining service years for which replacement power is required
x reactor power scaling factor

Dominion based its calculations on the value of 870 megawatts electric (MW[e]). Therefore, Dominion applied a power scaling factor of 870 MW(e)/910 MW(e) to determine the

replacement power cost. For the purposes of initial screening, which assumes all severe accidents are eliminated, Dominion calculated the RPC to be approximately $540,300.

Using the above equations, Dominion estimated the total present dollar value equivalent associated with completely eliminating severe accidents at MPS2 to be about $1,920,000.

Dominion's Results

The total benefit associated with each of the 44 SAMAs evaluated by Dominion is provided in Table H-3. These values were determined based on the above equations for the various averted costs together with the estimated annual reductions in CDF and population dose, and then increased by a multiplier of 1.3 to account for additional risk reduction in external events. The values for total benefit reported in Table H-3 include this multiplier. As a result, one of the 44 SAMAs was considered to be cost beneficial:

SAMA 3: Enhance loss of RBCCW procedure to ensure cool down of RCS prior to seal LOCA. The resolution of this issue is expected to be either a new procedure or a procedure modification that will require actions to prevent/mitigate a seal LOCA upon loss of RBCCW.

As stated in the ER, Dominion is addressing SAMA 3 as part of a comprehensive industry initiative in response to Generic Safety Issue 23, "Reactor Coolant Pump Seal Failure." Additionally, the CEOG is addressing this issue in CEOG Task 1136, "Model for Failure of RCP Seals Given Loss of Seal Cooling." The SAMA is anticipated to be implemented before the period of extended operation, and is being addressed under the current license (Dominion 2004b).

In response to an RAI, Dominion assessed the applicability and feasibility of several SAMAs considered by another CE plant. As a result, Dominion eliminated all of the SAMAs questioned except one — adding a capability to flash the field on the EDG (using a portable generator) to enhance SBO event recovery. Dominion stated that this SAMA is not expected to be cost-beneficial because it would likely require a plant modification to install a disconnect to allow the connection of a portable (temporary) generator, as well as development of a new SAMG. However, Dominion stated that if this SAMA can be accomplished via a SAMG without a hardware modification, the SAMA would be cost-beneficial and will be implemented prior to the period of extended operation (Dominion 2004b).

H.6.2 Review of Dominion's Cost-Benefit Evaluation

The cost-benefit analysis performed by Dominion was based primarily on NUREG/BR-0184 (NRC 1997b) and was conducted in a manner consistent with this guidance.

In order to account for uncertainties in the cost estimates, Dominion applied a factor of two margin in assessing whether SAMAs were cost-beneficial, i.e., a SAMA was considered to be cost-beneficial if the total benefit is within a factor of two of the estimated cost. The staff asked the applicant to consider the impact of uncertainty in the CDF (NRC 2004). In response, Dominion stated that CDF uncertainty calculations are not available in the current version of the Millstone PRA model. However, based on a review of recent SAMA analyses in support of license renewal, the 95th percentile CDF ranged from a factor of 2.0 to a factor of 6.4 greater than the mean CDF. Dominion stated that, in order to provide conservatism, it compared the costs to twice the calculated benefit. Dominion further indicated that most of the benefit calculations were performed in a bounding fashion, i.e., the SAMA is completely effective, and that such estimates would be substantially less if a more realistic analysis were performed for each SAMA (Dominion 2004b).

The staff questioned the approach of increasing the benefit (based on internal events) by 30 percent to account for external events (NRC 2004). In response to the RAI, Dominion stated that a multiplier of 1.3 was used because the external events analyses are not readily quantifiable (Dominion 2004b). The use of a multiplier on the benefits obtained from the internal events PRA to incorporate the impact of external events makes the implicit assumption that the consequences from external events sequences are the same as the consequences from internal events sequences. To demonstrate the robustness of the analysis, Dominion performed a sensitivity study that increased the assumed contribution from external events from 30 percent to 60 percent of the internal event benefits. The result was that the increased benefit exceeded the lower bound of the cost estimate range for only SAMA 3, which was already determined to be cost-beneficial. Therefore, Dominion concluded that the use of the 1.3 multiplier is acceptable.

Dominion assessed the impact of other factors on the analysis results, such as the contribution of external event initiators that were not explicitly included in the MPS2 risk profile, the use of a 3 percent discount rate as compared to the 7 percent discount rate used in the baseline calculations, as well as a 15-percent real discount rate (Dominion 2004a). These sensitivity cases resulted in an increase in the benefit calculation of about 30 percent or less. These analyses did not change Dominion's conclusion that none of the candidate SAMAs would be cost-beneficial except as noted above. In addition, Dominion performed sensitivity analyses that addressed assumptions made in other parts of the cost-benefit analysis, including meteorological data, source term, and evacuation. Dominion also considered the sensitivity to the impact of current and future fuel management practices. These sensitivity cases are bounded by the 3-percent discount rate sensitivity study.

The staff notes that accounting for each of these factors would tend to increase the benefit as compared to the baseline case analysis. However, the calculated benefits used in the baseline analysis are generally over estimated and, therefore, conservative. The staff concludes that the

use of the factor of two to account for uncertainties, coupled with the fact that the calculated benefits are generally conservative, provides a reasonable treatment of uncertainties and is adequate for the SAMA evaluation.

The staff questioned Dominion about lower cost alternatives to some of the SAMAs evaluated, including the use of a direct-drive diesel AFW pump (NRC 2004). In response, Dominion identified and evaluated several lower-cost alternatives to those considered in the ER. These alternatives included 1) installing a RBCCW header cross-tie, 2) using the hydrogen purge system as an unfiltered hardened containment vent, 3) using the existing systems to flood the reactor cavity, 4) providing reactor water storage tank makeup, and 5) using the diesel fire pump as a backup to the turbine-driven AFW pump. Dominion concluded that all of the alternatives considered are either covered by an existing procedure or SAMG, or could be instituted following evaluation and guidance by the Technical Support Center. With regard to the specific lower cost alternative involving a direct-drive diesel AFW pump, Dominion stated that the alternative would not be viable at MPS2 due to room and ventilation constraints as well as costs. Dominion further stated that MPS2 has a SAMG for using the diesel fire pump to provide water to the AFW system (Dominion 2004b).

The staff also questioned Dominion about several other candidate SAMAs that were found to be potentially cost-beneficial at another CE plant but not addressed by MPS2 analysis (NRC 2004). In response, Dominion provided an evaluation of the applicability and/or costs and benefits for these SAMAs at MPS2. Based on this assessment, all of the SAMAs were dismissed except one involving adding a capability to flash the field on the emergency diesel generator to enhance SBO event recovery. Dominion stated that the ability to flash the field on the EDG (using a portable generator) to enhance SBO event recovery would likely require a plant modification to install a disconnect to allow the connection of a portable (temporary) generator, as well as a new SAMG. However, If a hardware modification is not required, then the SAMA would be cost-beneficial. Dominion committed to complete its evaluation of this SAMA and develop a SAMG prior to the period of extended operation if it found to be cost-beneficial (Dominion 2004b).

The staff concludes that, with the exception of the two potentially cost-beneficial SAMAs discussed above, the costs of the SAMAs would be higher than the associated benefits. This conclusion is supported by uncertainty assessment and sensitivity analysis and upheld despite a number of additional uncertainties and nonquantifiable factors in the calculations, summarized as follows:

- A factor of two was used to account for uncertainties. Even if a higher factor were considered to reflect a larger uncertainty in CDF, e.g., a factor of five, only two additional SAMAs would be close to becoming cost-beneficial — SAMAs 150 and 175. However, these SAMAs involve hardware modifications that are not expected to be cost-beneficial under more realistic assumptions regarding risk reduction.

- Sensitivity calculations were performed with respect to the discount rate (3 percent and 15 percent) and various MACCS2 parameters, including meteorological data, evacuation speed, evacuation delay time, and source terms. The results of these sensitivity studies showed that none of the risk benefits were increased by more than 30 percent. Since this is less than the margin between cost and benefit for the SAMAs considered, the uncertainties in these parameters would not alter the conclusions.

H.7 Conclusions

Dominion compiled a list of 196 SAMA candidates using the SAMA analyses as submitted in support of licensing activities for other nuclear power plants, NRC and industry documents discussing potential plant improvements, plant-specific insights from the MPS2 PRA model. A qualitative screening removed SAMA candidates that (1) were not applicable at MPS2 due to design differences, (2) had already been implemented at MPS2, or (3) were related to RCP seal vulnerability. A total of 152 SAMAs were eliminated, leaving 44 for further evaluation.

For the remaining SAMA candidates, a more detailed design and cost estimate were developed as shown in Table H-3. The cost-benefit analyses showed that one of the SAMA candidates was cost-beneficial. Upon completion of a 3-percent discount rate sensitivity study, as well as other sensitivity studies, no additional SAMA candidates were determined to be cost-beneficial. To account for uncertainties, Dominion compared the costs of the SAMA with twice the calculated benefit. As a result, no additional SAMAs were cost-beneficial.

The staff reviewed the Dominion analysis and concluded that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs, the generally large negative net benefits, and the inherently small baseline risks support the general conclusion that the SAMA evaluations performed by Dominion are reasonable and sufficient for the license renewal submittal. The unavailability of an external event PRA model precluded a quantitative evaluation of SAMAs specifically aimed at reducing risk of external event initiators; however, improvements that have been realized as a result of the IPEEE process and the inclusion of a multiplier to account for external events would minimize the likelihood of there being cost-beneficial enhancements in this area.

Based on its review of the Dominion SAMA analysis, the staff concurs that none of the candidate SAMAs are cost-beneficial, except for SAMA 3 and possibly an additional SAMA involving adding a capability to flash the field on the EDG (using a portable generator) to enhance SBO event recovery. This is based on conservative treatment of costs and benefits. This conclusion is consistent with the low residual level of risk indicated in the MPS2 PRA and the fact that MPS2 has already implemented many of plant improvements identified from the IPE and IPEEE processes. Although the one SAMA candidate is cost-beneficial and a second SAMA may be cost-beneficial if it can be implemented via procedural enhancements, neither of

these SAMAs relates to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

H.8 References

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Appendix I

NRC Staff Evaluation of Severe Accident Mitigation Alternatives (SAMAs) for Millstone Power Station, Unit 3, in Support of the License Renewal Application Review

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NRC Staff Evaluation of Severe Accident Mitigation Alternatives (SAMAs) for Millstone Power Station, Unit 3, in Support of the License Renewal Application Review

I.1 Introduction

Dominion Nuclear Connecticut, Inc. (Dominion) submitted an assessment of SAMAs for Millstone Power Station, Unit 3 (MPS3) as part of the Environmental Report (ER) (Dominion 2004a). This assessment was based on the most recent MPS3 Probabilistic Risk Assessment (PRA) available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the MPS3 Individual Plant Examination (IPE) (NNECO 1990) and Individual Plant Examination of External Events (IPEEE) (NNECO 1991). In identifying and evaluating potential SAMAs, Dominion considered SAMA analyses performed for other operating plants, as well as industry and NRC documents that discuss potential plant improvements, such as NUREG-1560 (NRC 1997a). Dominion identified 185 potential SAMA candidates. This list was reduced to 52 unique SAMA candidates by eliminating SAMAs that were not applicable to MPS3 due to design differences, had already been implemented, or were related to a reactor coolant pump (RCP) seal loss of coolant accident (LOCA). Dominion assessed the costs and benefits associated with each of the remaining SAMAs and concluded in the ER that none of the candidate SAMAs evaluated would be cost-beneficial for MPS3.

Based on a review of the SAMA assessment, the NRC issued a request for additional information (RAI) to Dominion by letter dated June 22, 2004 (NRC 2004). Key questions concerned the following areas: peer reviews of the PRA, dominant risk contributors at MPS3 and the SAMAs that address these contributors, the mapping of Level 1 PRA results into the Level 2 analysis, the potential impact of external event initiators and uncertainties on the assessment results, detailed information on some specific candidate SAMAs, and consideration of additional SAMAs. Dominion submitted additional information by letter dated August 13, 2004 (Dominion 2004b) including summaries of peer review comments and their impact on the SAMA analysis; importance measures and corresponding SAMA candidates; information regarding the Level 2 analysis; information related to the resolution of IPEEE outliers and the impact of external events in the risk analysis; an assessment of the impact of uncertainties; and additional information regarding specific SAMAs. Dominion's responses

addressed the staff's concerns. As a result, Dominion identified one SAMA that would be cost-beneficial if it can be accomplished via a severe accident management guideline, without a hardware modification.

An assessment of SAMAs for MPS3 is presented below.

I.2 Estimate of Risk for MPS3

Dominion's estimates of offsite risk at MPS3 are summarized in Section I.2.1. The summary is followed by the staff's review of Dominion's risk estimates in Section I.2.2.

I.2.1 Dominion's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the MPS3 Level 1 and 2 PRA model, which is an updated version of the IPE (NNECO 1990), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The identification of candidate SAMAs was based on Revision 4 of the PRA model, dated October 1999; the quantification of SAMA benefits was based on an October 2002 update of the PRA (referred to as Revision 0, using a new naming convention) (Dominion 2004b). The scope of the MPS3 PRA does not include external events.

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 2.57×10^{-5} per year. The CDF is based on the risk assessment for internally initiated events. Dominion did not include the contribution to risk from external events or internal flooding within the MPS3 risk estimates; however, it did account for the potential risk reduction benefits associated with external events by increasing the estimated benefits for internal events by 60 percent. This is discussed further in Sections I.4 and I.6.2.

The breakdown of CDF by initiating event is provided in Table I-1. As shown in this table, LOCAs, RCP seal LOCAs, transients including anticipated transients without scram (ATWS), and loss of offsite power (LOOP) are dominant contributors to the CDF. Bypass events (i.e., steam generator tube rupture [SGTR] and interfacing systems LOCA [ISLOCA])] contribute less than 5 percent to the total internal events CDF. The contribution to CDF from internal floods is estimated to be 8.6×10^{-7} per year (NNECO 1990).

The Level 2 PRA model is based on the Level 2 model used in the Millstone Unit 3 Probabilistic Safety Study (NNECO 1983) and the IPE (NNECO 1990). The result of this analysis is a set of formulae for transforming the MPS3 plant damage state (PDS) frequencies into containment

release category frequencies. The source terms for each release category (also termed the source term category) were obtained from the results of MAAP 4 analyses of the dominant core damage sequences in the IPE.

Table I-1. MPS3 Core Damage Frequency

Initiating Event or Accident Class	CDF (Per Year)	% Contribution to CDF
RCP Seal LOCA	5.66×10^{-6}	22.0
Transients	4.04×10^{-6}	15.7
LOCAs	3.42×10^{-6}	13.3
LOOP	2.77×10^{-6}	10.8
ATWS	2.39×10^{-6}	9.3
Steamline break inside containment	2.31×10^{-6}	9.0
Station blackout (SBO)	1.78×10^{-6}	6.9
Total loss of service water	1.28×10^{-6}	5.0
SGTR	1.00×10^{-6}	3.9
Loss of one vital DC bus	4.18×10^{-7}	1.6
Steamline break outside containment	3.79×10^{-7}	1.5
ISLOCA	2.21×10^{-7}	0.9
Instrument tube LOCA	5.04×10^{-8}	0.2
Total CDF	**2.57×10^{-5}**	**100**

The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and public. Inputs for this analysis include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution within a 80 kilometer (km) (50-mile [mi]) radius for the year 2040, emergency response evacuation modeling, and economic data. The core radionuclide inventory is based on the generic pressurized water reactor (PWR) inventory provided in the MACCS2 manual, adjusted to represent the MPS3 power level of 3411 megawatts thermal (MW[t]). The magnitude of the onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC 1997b).

In the ER, Dominion estimated the dose to the population within 80 km (50 mi) of the MPS3 site to be approximately 0.128 person-sieverts (person-Sv) (12.8 person-roentgen equivalent man [person-rem]) per year. The breakdown of the total population dose by containment release

mode is summarized in Table I-2. Late-containment failures dominate the population dose risk at MPS3, followed by SGTR and ISLOCAs. Early failures and containment isolation failures are each indicated to be zero contributors to risk. As indicated in the response to an RAI, these release modes were deleted from the IPE model because of low contribution (i.e., <0.1 percent) (Dominion 2004b).

Table I-2. Breakdown of Population Dose by Containment Release Mode (Unit 3)

Containment Release Mode	Population Dose (Person-rem[a] Per Year)	% Contribution
Late failure	6.60	51.5
SGTR	2.77	21.6
ISLOCA	2.23	17.4
Intermediate failure	0.93	7.2
No containment failure	0.24	1.9
Basemat failure	0.05	0.4
Early failure	0	0
Containment isolation failure	0	0
Total Population Dose	**12.8**	**100**

(a) One person-rem = 0.01 person-Sv

I.2.2 Review of Dominion's Risk Estimates

Dominions's determination of offsite risk at MPS3 is based on the following three major elements of analysis:

- the Level 1 and 2 risk models that form the bases for the 1990 IPE submittal (NNECO 1990) and the 1991 IPEEE submittal (NNECO 1991),
- the major modifications to the IPE models that have been incorporated in the MPS3 PRA, and
- the MACCS2 analyses performed to translate fission product source terms and release frequencies from the Level 2 PRA model into offsite consequence measures.

Each of these analyses was reviewed to determine the acceptability of Dominion's risk estimates for the SAMA analysis, as summarized below.

The staff's review of the MPS3 IPE is described in an NRC report dated May 5, 1992 (NRC 1992). Based on a review of the original IPE submittal, the staff concluded that IPE submittal met the intent of Generic Letter 88-20 (NRC 1988); that is, the IPE was of adequate quality to be used to look for design or operational vulnerabilities. The staff did, however, identify a number of weaknesses in the IPE analysis. In response to an RAI, Dominion indicated that all of these weaknesses have been addressed in the PRA used for the SAMA analysis (Dominion 2004b).

A comparison of internal events risk profiles between the IPE and the PRA used in the SAMA analysis indicates a decrease of approximately 3×10^{-5} per year in the total CDF (from 5.52×10^{-5} per year to 2.57×10^{-5} per year). The change is a net result of modeling improvements and some minor plant design changes that have been implemented at MPS3 since the IPE was submitted. A summary listing of those changes that resulted in the greatest impact on the total CDF was provided in the ER and in response to an RAI (Dominion 2004a, 2004b), and include the following:

- modified the SBO logic to consider the SBO diesel battery capacity limitation and hardware/procedural changes implemented to cope with the condition,
- incorporated the latest revision of the MPS3 plant-specific database,
- modified the SBO event tree to incorporate the results of core uncovery time based on the most probable RCP seal LOCA leakage rates,
- incorporated the accident sequence analysis for LOCAs, SBO, ATWS, and total loss of service water (SW),
- removed initiating events associated with common cause failure (CCF) to run 3 and 4 SW pumps, based on industry guidance on identification of CCF groupings.

An additional change that has a significant impact on the CDF value is the truncation value used in the PRA model. For the PRA version used for the SAMA analysis, Dominion used a truncation value of 1.0×10^{-11}. In contrast, use of a truncation value of 2.0×10^{-9} (as used in previous versions of the PRA) would result in a CDF of about 2.04×10^{-5} per year rather than a value of 2.57×10^{-5} per year as used in the SAMA analysis.

The IPE CDF value for MPS3 is comparable to the CDF values reported in the IPEs for other Westinghouse PWR plants. Figure 11.6 of NUREG-1560 shows that the IPE-based total internal events CDF for four-loop Westinghouse plants ranges from 4×10^{-6} to 3×10^{-4} per year (NRC 1997a). It is recognized that other plants have reduced the values for CDF subsequent

to the IPE submittals due to modeling and hardware changes. The current internal events CDF results for MPS3 remain comparable to the results for other plants of similar vintage and characteristics.

The staff considered the peer review performed for the MPS3 PRA, and the potential impact of the review findings on the SAMA evaluation. In response to an RAI, Dominion described the external peer review, which was the Westinghouse Owners Group Peer Review performed in September 1999 (Dominion 2004b). The review resulted in four Level A facts and observations (extremely important and necessary) and 41 Level B facts and observations (important and necessary but may be delayed until next update). Two of the Level A and 24 of the Level B recommendations are yet to be incorporated. The Level A recommendations not yet incorporated are in the areas of accident sequence analysis and human reliability analysis. Both involve the completeness of the treatment of pre-initiator human errors. The Level B recommendations not yet incorporated affect essentially all PRA elements. Dominion has reviewed all of the unresolved facts and observations and concluded that they have negligible impact on the SAMA analysis (Dominion 2004b). The staff has also reviewed Dominion's assessment of the impacts of the outstanding peer review comments and has come to the same conclusion.

Given that (1) the MPS3 PRA has been peer reviewed and the potential impact of the peer review findings on the SAMA evaluation has been assessed, (2) Dominion satisfactorily addressed staff questions regarding the PRA (Dominion 2004b), and (3) the CDF falls within the range of contemporary CDFs for Westinghouse plants, the staff concludes that the Level 1 PRA model is of sufficient quality to support the SAMA evaluation.

The licensee included external events in the IPE submittal in August 1990 (NNECO 1990). The external events analysis in the IPE/IPEEE is taken from the "Millstone Unit 3 Probabilistic Safety Study" (NNECO 1983). This submittal and several updates were reviewed extensively by the NRC staff as documented in NUREG-1152 (NRC 1985a) and by contractors as documented in NUREG/CR-4142 (NRC 1985b) and NUREG/CR-4143 (NRC 1985c). While the IPEEE submittal did not identify any vulnerabilities to severe accident risk from external events, a number of minor improvements were identified. In a letter dated May 26, 1998, the staff concluded that the IPEEE submittal met the intent of Supplement 4 to Generic Letter 88-20, and that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities (NRC 1998).

The seismic PRA performed for MPS3 resulted in a seismic CDF of 9.1×10^{-6} per year. The dominant contributor to this was seismically induced SBO. In NUREG-1152, the staff recommended that two alternatives be further evaluated (improve the anchorage system for the emergency diesel generator lube oil coolers and add a manually-operated, AC independent containment spray system). In response to an RAI, Dominion indicated that the first of these

alternatives has been implemented at MPS3. Dominion provided additional information concerning the costs related to the other alternative. Dominion concluded that, because of adequate seismic margins and the complexity associated with increasing the seismic capacity of a structures and components, no cost-effective SAMAs could be identified (Dominion 2004b). The staff agrees that it is unlikely that cost-effective SAMAs to further reduce seismic risk will exist. This is due to high cost of structural modifications compared to the benefits expected.

The fire PRA performed for MPS3 resulted in a fire CDF of 4.9×10^{-6} per year. The dominant contributors are fires in the charging and component cooling pump area, cable spreading area, and control room. The dominant fire areas and the associated CDF for those areas are:

Fire Area	Description	CDF (per year)
AB-1	Charging and component cooling pumps area	1.07×10^{-6}
CB-8	Cable spreading area	9.89×10^{-7}
CB-9	Control room	7.28×10^{-7}

A subsequent modification to the fire detection system in the cable spreading area has reduced the CDF in this area to 3.75×10^{-7} per year (Dominion 2004b).

In a RAI, the staff asked Dominion to explain, for each important fire area, what measures were taken to further reduce risk, and explain why these CDFs cannot be further reduced in a cost-effective manner (NRC 2004). For each area, Dominion provided a discussion of the major fire contributors assumed in the analysis and the existing plant features to address fire events. Dominion identified several improvements that have been implemented to address fire-related issues. Dominion also discussed the potential for further cost-effective hardware changes to address the fire-related matters listed above, including improvements to detection systems, enhancements to suppression capabilities, and changes that would improve cable separation and train separation (Dominion 2004b). Dominion concluded that no further modifications would be cost-effective for any of the fire areas.

The staff notes that although additional SAMAs to reduce the fire risk contributors might be viable, given the low level of risk from fires and the improvements that have already been implemented, it is unlikely that further modifications would both substantially reduce risk and remain cost-beneficial.

In the SAMA analysis, Dominion accounted for the additional risk contribution due to external events by increasing the benefit derived from the internal events model by 60 percent. This was determined by summing the following CDF contributions:

- Fire 4.9×10^{-6} per year
- Internal flooding 0.9×10^{-6} per year
- Seismic 9.1×10^{-6} per year

The fire contribution is discussed above. The internal flooding CDF of 8.6×10^{-7} per year was obtained directly from the MPS3 IPE (NNECO 1990). This value is the result of a bounding, screening-type analysis. The total external events CDF from the above is 1.49×10^{-5} per year, or approximately 58 percent of the CDF due to internal events. This was rounded up to 60 percent for the SAMA analysis.

The MPS3 Level 2 PRA analysis is based on the IPE (NNECO 1990). The result of this analysis is a set of formulae for transforming the MPS3 plant damage state (PDS) frequencies into containment release category frequencies. This is described in Section I.2.3 of the ER (Dominion 2004a), and further clarified in response to RAIs (Dominion 2004b, 2004c). The formulae and the release category frequencies are provided in Tables I.2-4 and I.2-6 of the ER, respectively (Dominion 2004a). The release fractions for each release category were obtained from MAAP 4 analysis for the dominant sequences in the IPE and are provided in Table I.1-2 of the ER (Dominion 2004a). In response to an RAI concerning the use of IPE dominant sequences to determine the release fractions used in the SAMA analysis, Dominion provided a discussion and a comparison of the PDSs and release categories for the IPE and SAMA analyses (Dominion 2004b). The staff reviewed Dominion's source term estimates for the major release categories and found the release fractions to be within the range of the release fractions for like plants. Dominion also provided results of several sensitivity studies relative to the source term and release characteristics including doubling the plume release height, doubling the duration of source term release time, and varying source term release fractions. The results showed that these parameter variations had only a minor impact (less than 20 percent) on the estimated dollar benefits for the candidate SAMAs. The staff concludes that the process used for determining the release category frequencies and source terms is reasonable and appropriate for the purposes of the SAMA analysis.

During the staff's review of the Level 2 model, the staff identified an error in the formulae used to translate PDS frequencies into release category frequencies. Dominion confirmed the error and determined that it resulted in a slight overestimation of the benefits for candidate SAMAs, which is conservative for the cost-benefit analysis (Dominion 2004b).

As discussed previously, the fission product inventory used in the consequence analysis is based on a fission product inventory scaled from generic information. In response to an RAI concerning the impact of current and future fuel management practices, Dominion described a conservative bounding analysis of core fission product inventory considering a range of enrichments and burnups (Dominion 2004b). Using this inventory would result in a 28-percent increase in total benefit from eliminating all risk. Using realistic mid-life or average conditions

would result in a smaller increase in the maximum benefit. The staff concludes that the scaling based on the plant-specific power level yields sufficiently accurate and reasonable results for the dose assessment.

The staff reviewed the process used by Dominion to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (essentially a Level 3 PRA). This included consideration of the major input assumptions used in the offsite consequence analyses. The MACCS2 code was utilized to estimate offsite consequences. Plant-specific input to the code includes the source terms for each release category and the MPS3 reactor core radionuclide inventory (both discussed above), site-specific meteorological data, projected population distribution within a 80 km (50 mile) radius for the year 2040, and emergency evacuation modeling. This information is provided in Appendix G to the ER (Dominion, 2004a).

Dominion used site-specific meteorological data processed from hourly measurements for the 2000 calendar year as input to the MACCS2 code. The hourly data (wind direction, wind speed, and stability class) were collected from the onsite meteorological tower. Precipitation data were recorded at the Green Airport near Providence, Rhode Island, the closest weather station to Millstone. Morning and afternoon mixing height values were obtained from the National Climatic Data Center. The applicant also considered the impact on SAMA benefits of using meteorological data for 1998 and 1999. The results of these sensitivity cases showed that the benefits increased by an average of about five percent. The staff considers the use of the 2000 data in the base case to be reasonable.

The population distribution the applicant used as input to the MACCS2 analysis was estimated for the year 2040, based primarily on SECPOP90 (NRC 1997c). U.S. Census Bureau Year 2000 population data, projected to year 2040, was then used to update the SECPOP90 population data (Dominion 2004a). The staff questioned the difference between the use of SECPOP90 and SECPOP2000, and what the impact would be if the latter was used. In response, Dominion noted that the expected impact of using SECPOP2000 would be negligible since census data from 2000 was used to update the SECPOP90 file. The staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA evaluation.

The emergency evacuation model was modeled as a single evacuation zone extending out 16 km (10 mi) from the plant. It was assumed that 100 percent of the population would move at an average speed of approximately 1.49 meters per second with a delayed start time of 7200 seconds from the offsite alarm reference time point (Dominion 2004a). Dominion performed sensitivity studies exploring the impact of the fraction of population that evacuates and the evacuation speed. The results demonstrated that the total dose and economic cost results are

insensitive to these parameters (Dominion 2004a). The staff concludes that the evacuation assumptions and analysis are reasonable and acceptable for the purposes of the SAMA evaluation.

Much of the site-specific economic data were provided from SECPOP90 (NRC 1997c) by specifying the data for counties surrounding the plant to a distance of 50 miles. The SECPOP90 input file was updated to 2001 using cost of living and other data from the Bureau of the Census and the Department of Agriculture (Dominion 2004). The agricultural economic data were updated using available data from the 1997 Census of Agriculture (USDA 1998).

The staff concludes that the methodology used by Dominion to estimate the offsite consequences for MPS3 provides an acceptable basis from which to proceed with an assessment of risk reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDF and offsite doses reported by Dominion.

I.3 Potential Plant Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by Dominion are discussed in this section.

I.3.1 Process for Identifying Potential Plant Improvements

Dominion's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- review of the most significant basic events from the MPS3 PRA Model, Rev. 4 (October 1999),
- review of items not already evaluated and/or implemented during the IPE and IPEEE,
- review of SAMA analyses submitted in support of original licensing and license renewal activities for other operating nuclear power plants, and
- review of other NRC and industry documentation discussing potential plant improvements.

Based on this process, an initial set of 185 candidate SAMAs was identified. In Phase 1 of the evaluation, Dominion performed a qualitative screening of the initial list of SAMAs and eliminated SAMAs from further consideration using the following criteria:

- the SAMA is not applicable at MPS3,

- the SAMA has already been implemented at MPS3, or the MPS3 design meets the intent of the SAMA, or
- the SAMA is related to a RCP seal vulnerability stemming from charging pump dependency on component cooling water (CCW). (MPS3 does not have this vulnerability because the charging pumps do not rely on CCW for RCP seal injection.)

Based on this screening, 133 SAMAs were eliminated leaving 52 for further evaluation. Of the SAMAs eliminated, 47 were eliminated because they were not applicable, 77 were eliminated because they already had been implemented, and 9 were eliminated because they were related to RCP seal vulnerability. A cost estimate was prepared for each of the 52 remaining candidates to focus on those that had a possibility of having a net positive benefit. To account for the potential impact of external events, the estimated benefits based on internal events of each SAMA were multiplied by a factor of 1.6 for all SAMAs except those related to ISLOCA and SGTR-initiated events.

The 52 SAMAs were evaluated and subsequently eliminated, as described in Sections I.4 and I.6.1 below.

I.3.2 Review of Dominion's Process

Dominion's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events. The initial list of SAMAs generally addressed the accident categories that are dominant CDF contributors or issues that tend to have a large impact on a number of accident sequences at MPS3.

The preliminary review of Dominion's SAMA identification process raised some concerns regarding the completeness of the set of SAMAs identified and the inclusion of plant-specific risk contributors. The staff requested additional information regarding the top 30 cut sets and certain sequences (NRC 2004). In response to the RAI, Dominion provided a listing of the top contributors to risk, the associated plant damage state, and a cross-reference between the top contributors to risk from a later version of the PRA and the SAMAs that addressed those risk contributors (Dominion 2004b).

The staff noted that Dominion based the SAMA identification process on PRA Revision 4 (dated October 1999) and the SAMA quantification on an October 2002 update of the PRA (referred to as Revision 0). The staff questioned Dominion regarding the impact on the SAMA identification process if the later version of the PRA was used to identify potential SAMAs (NRC 2004). In response, Dominion reassessed the SAMA identification process considering the later PRA revision. The basic events not included in the initial Unit 3 PRA importance list were identified. Those events with a risk reduction worth greater than or equal to 1.005 from the more recent

PRA model were specifically evaluated. These events were compared to the SAMA list to determine which events were already addressed by a SAMA. Dominion determined that all of the additional basic events map to previously identified SAMAs. As a result, no new SAMAs were created (Dominion 2004c). Based on these additional assessments, Dominion concluded that the set of 185 SAMAs evaluated in the ER addresses the major contributors to CDF and offsite dose, and that the review of the top risk contributors does not reveal any new SAMAs.

The staff questioned Dominion regarding use of the second screening criterion (i.e., screening out a SAMA on the basis that it has already been implemented at MPS3) to eliminate SAMAs that were identified based on review of the PRA (NRC 2004). In response, Dominion provided qualitative or quantitative details on the plant-specific SAMAs that were screened using this criterion (SAMAs 159, 163, 165, 166, 167, 174, 181 and 185). None of these SAMAs were determined to be cost-beneficial based on this further evaluation.

The staff questioned Dominion about lower-cost alternatives to some of the SAMAs evaluated, including the use of portable battery chargers and a direct-drive diesel auxiliary feedwater (AFW) pump (NRC 2004). In response, Dominion identified several lower-cost alternatives, all of which are covered by an existing procedure or severe accident management guideline (SAMG), or could be instituted following evaluation and guidance by the Technical Support Center. This is discussed further in Section I.6.2.

The staff notes that the set of SAMAs submitted is not all inclusive, since additional, possibly even less expensive, design alternatives can always be postulated. However, the staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least-expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The staff concludes that Dominion used a systematic and comprehensive process for identifying potential plant improvements for MPS3, and that the set of potential plant improvements identified by Dominion is reasonably comprehensive and therefore acceptable. This search included reviewing insights from the IPE and IPEEE and other plant-specific studies, reviewing plant improvements considered in previous SAMA analyses, and using the knowledge and experience of its PRA personnel. While explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for seismic and fire events and the absence of external event vulnerabilities reasonably justifies examining primarily the internal events risk results for this purpose.

I.4 Risk Reduction Potential of Plant Improvements

Dominion evaluated the risk-reduction potential of the 52 remaining SAMAs that were applicable to MPS3. A majority of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement. Such bounding calculations overestimate the benefit and are conservative.

Dominion estimated the potential benefits for each SAMA by generating a revised set of PDS frequencies. Using these revised frequencies, a revised Level 3 (dollars averted) calculation was performed. The benefit was calculated using the fault trees, event trees, and databases from Revision 0 of the MPS3 PRA. The assumptions made to evaluate the benefit were provided in response to an RAI (Dominion 2004b, 2004c). Table I-3 lists the assumptions considered to estimate the risk reduction for each of the evaluated SAMAs, the estimated risk reduction in terms of percent reduction in CDF and population dose, and the estimated total benefit (present value) of the averted risk (including the 1.6 multiplier to account for benefits in external events). The determination of the benefits for the various SAMAs is further discussed in Section I.6.

The staff has reviewed Dominion's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on Dominion's risk reduction estimates. The estimated risk reduction for several of the SAMAs was negligible or zero. In these instances, the SAMA either affects sequences or phenomena that do not contribute to risk at MPS3, or represents an ineffective plant improvement. As such, a minimal impact on risk is not unreasonable in those cases.

I.5 Cost Impacts of Candidate Plant Improvements

Dominion personnel experienced in estimating the cost of performing work at a nuclear plant estimated the costs of implementing the 52 candidate SAMAs. For some of the SAMAs considered, the cost estimates were sufficiently greater than the benefits calculated that it was not necessary to perform a detailed cost estimate. Cost estimates typically included procedures, engineering analysis, training, and documentation, in addition to any hardware.

The staff reviewed the bases for the applicant's cost estimates (presented in Section I.3 of Appendix G to the ER). For certain improvements, the staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. The cost estimates provided were in the form of ranges. For purposes of evaluating specific SAMAs, the staff selected the low end values from the range to represent the costs.

Table I-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 3

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
9 - Provide additional SW pump that can be connected to either SW header	Set failures of SW pumps and CCF of SW pumps to zero	8.5	9.6	164,800	10,000,000
10 - Create an independent RCP seal cooling system with dedicated diesel	Eliminate the need for RCP cooling from the fault tree	22.8	22.3	419,800	10,000,000
11 - Create an independent RCP seal cooling system without dedicated diesel	Same as SAMA #10	22.8	22.3	419,800	5,000,000
20/21 - Develop a new procedure for cross-tying either the CCW pumps or SW pumps (including analysis, validation, and training)	Changed fault tree from failure of one train to failure of one train of SW AND failure of the opposite train or failure of operator action to align the opposite train (prob. 0.10)	1.7	0.3	14,100	150,000
34 - Install a containment vent large enough to remove ATWS decay heat	Set failure of reactor protection system electrical components (except reactor trip breakers), CCF of reactor trip breakers, CCF of 10 or more control rods to insert, and CCF of 35 or more control rods to insert to zero	9.3	1.3	103,400	10,000,000
35 - Install a filtered containment vent to remove decay heat	Set CCF of recirculation air conditioning units to operate, misalignment of manual valve 3RHS*V43, loss of the recirculation spray system, CCF of motor-operated valves (MOV) 3SWP*MOV50A/B to close, and CCF of 3SWP*MOV71A/B to close to zero	5.8	6.4	110,800	12,000,000

Table I-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 3

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
36 - Install an unfiltered hardened containment vent	Same as SAMA #35	5.8	6.4	110,800	10,000,000
43 - Create a reactor cavity flooding system	Set release categories with intermediate and late containment failure and basemat failure to zero	<0.1	41.9	344,800	18,000,000
44 - Creating other options for reactor cavity flooding	Same as SAMA #43	<0.1	41.9	344,800	18,000,000
60 - Provide additional DC battery capability	Lengthen time for restoration of offsite power to become available to prolong DC battery life	2.2	2.6	42,800	600,000
61 - Use fuel cells instead of lead-acid batteries	Same as SAMA #60	2.2	2.6	42,800	3,000,000
63 - Improved bus cross tie ability	Changed fault tree from failure of one AC bus to failure of one AC bus AND failure of the opposite AC bus or failure of operator action to align the opposite AC bus (prob. 0.01)	27.8	17.9	429,600	2,000,000
64 - Alternate battery charging capability	Same as SAMA #60	2.2	2.6	42,800	5,000,000
67 - Create AC power cross tie capability across units	Create cross-tie logic (prob. 0.02) with the Millstone Power Station, Unit 2 (MPS2) emergency diesel generators (EDGs) in the fault tree	8.6	10.4	170,800	4,000,000
73 - Install gas turbine generators	Set failures of EDGs 'A' and 'B' and CCF of EDGs 'A' and 'B' to zero	29.9	24.2	500,100	8,000,000

Table I-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 3

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
75 - Create a river water backup for diesel cooling	Same as SAMA #76	0.7	0.5	11,100	750,000
76 - Use firewater as a backup for diesel cooling	Eliminate failures of SW supply to the EDGs from the fault tree	0.7	0.5	11,100	750,000
77 - Provide a connection to alternate offsite power source (the nearest dam)	Eliminate failures of LOOP from the fault tree	38.4	30.0	635,100	6,000,000
80 - Create an auto-loading of the SBO diesel	Set failure of the operator to correctly start and align the SBO diesel to zero	2.4	2.9	47,400	7,000,000
87 - Replace steam generators with new design	Eliminate the possibility of SGTR events from the fault tree	3.5	21.6	144,800	175,000,000
93 - Additional instrumentation and inspection to prevent ISLOCA sequences	Set the ISLOCA containment release category frequency to zero	0.8	17.4	83,600	9,000,000
94 - Increase frequency of valve leak testing	Same as SAMA #93	0.8	17.4	83,600	2,000,000
99 - Ensure all ISLOCA releases are scrubbed	Same as SAMA #93	0.8	17.4	83,600	4,000,000
100 - Add redundant and diverse limit switch to each containment isolation valve	Same as SAMA #93	0.8	17.4	83,600	18,000,000
112 - Proceduralize local manual operation of AFW when control power is lost	Set all recoveries of offsite power to zero	2.2	2.6	42,800	100,000

Table I-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 3

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
113 - Provide portable generators to be hooked in to the turbine driven AFW train after battery depletion	Bounded by SAMA #112	1.9	2.3	38,400	5,000,000
120 - Create passive secondary side coolers	Eliminate failures of the AFW system from the fault tree	40.6	15.4	532,900	50,000,000
123 - Provide capability for diesel-driven, low pressure vessel makeup	Eliminate failures of the emergency core cooling system injection from the fault tree	19.7	22.9	396,000	7,500,000
124/125 - Provide an additional high pressure injection (HPSI) pump with independent diesel	Set failures of HPSI pumps and CCF of HPSI pumps to zero	3.5	1	42,800	10,000,000
138 - Create automatic swapover to recirculation on refueling water storage tank depletion	Set failure of operator to establish sump recirculation after a LOCA to zero	1.7	0.3	19,800	2,000,000
156 - Install secondary side guard pipes up to the main steam isolation valves (MSIVs)	Eliminate steam line break inside containment from the fault tree	13.4	22.5	335,700	10,000,000
160 - Install turbine-driven AFW pump	Set failures of the turbine-driven AFW pumps to zero	42.0	33.5	712,200	12,000,000
161 - Install SBO diesel	Set failures of the SBO diesel to zero	5.3	6.4	105,400	8,000,000
162 - Install charging system train	Set failures of charging pumps and CCF of charging pumps to zero	7.2	3.6	103,300	20,000,000
164 - Install safety injection train	Set failures of HPSI pumps and CCF of HPSI pumps to zero	3.5	1	42,800	20,000,000
168 - Automate feed and bleed	Set failures of operator to establish feed and bleed cooling to zero	28.8	21.5	480,800	1,000,000
169 - Improve boron injection reliability with new procedure and hardware	Eliminate failures of emergency boration from the fault tree	0	0	0	2,000,000
170 - Add another air-operated valve (AOV) to isolate SW	Set failures of MOVs 3SWP*MOV50A/B and 3SWP*MOV71A/B to close, CCF of 3SWP*MOV50A/B to close, and CCF of 3SWP*MOV71A/B to close to zero	7.1	8.9	143,800	2,000,000

Table I-3. SAMA Cost-Benefit Screening Analysis for Millstone Power Station, Unit 3

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)	Cost ($)
		CDF	Population Dose		
171 - Install another containment recirculation system (RSS) parallel flow path	Same as SAMA #172	1.7	1.5	28,800	10,000,000
172 - Add a redundant train of RSS	Set failures of RSS pumps and CCF of RSS pumps to zero	1.7	1.5	28,800	20,000,000
173 - Add additional SW AOVs (air-to-close/air-to-open)	Same as SAMA #170	7.1	8.9	143,800	2,000,000
175 - Add a redundant DC bus	Set failures of vital 120 VDC buses 301A1 and 301B1 to zero	0.3	0.5	7,000	5,000,000
176 - Add a redundant charging pump	Set failures of the charging pumps and CCF of the charging pumps to zero	7.2	3.6	103,300	10,000,000
177 - Add a redundant block valve for the power-operated relief valve (PORV)	Eliminate failures of the PORVs to reseat from the fault tree	3.4	2.5	55,100	2,000,000
178 - Add redundant MSIVs	Eliminate failures of the MSIVs to close from the fault tree	0.8	0.2	10,000	5,000,000
179 - Add a redundant SW pump ventilation train	Eliminate failure of the SW train 'A' and train 'B' pump cubicle ventilation from the fault tree	2.1	1.7	34,700	1,000,000
180 - Add a redundant valve in series to isolate the steam line dumps to condenser	Eliminate failures of the steam dump valves to the condenser from the fault tree	4	0.5	44,300	5,000,000
182 - Add redundant AC bus	Changed fault tree from failure of one AC bus to failure of one AC bus AND failure of the opposite AC bus or failure of operator to align the opposite AC bus (prob. 0.01)	27.8	17.9	429,600	15,000,000
183 - Add redundant AFW flow path	Set CCF of the discharge and injection AFW check valves to open to zero	0.9	0.3	11,200	15,000,000
184 - Add redundant demineralized water storage tank (DWST)	Set failure of the DWST to zero	0.8	0.2	9,800	5,000,000

For some SAMAs, the costs appeared to be overestimated. Therefore, the staff asked the applicant to justify the costs for those SAMAs that had significant benefits (NRC 2004). In response to the staff's request, Dominion provided a discussion of the components and activities that were considered in estimating the costs of those SAMAs for which the benefit was determined to be $50,000 or more. The discussion included a description of the modification, if any procedure changes and training would be required, and if any new instrumentation and maintenance would be required (Dominion 2004b). The staff reviewed the costs and subsequent explanations and found them to be reasonable and generally consistent with estimates provided in support of other plants' analyses.

The staff concludes that the cost estimates provided by Dominion are sufficient and appropriate for use in the SAMA evaluation.

I.6 Cost-Benefit Comparison

Dominion's cost-benefit analysis and the staff's review are described in the following sections.

I.6.1 Dominion Evaluation

The methodology used by Dominion was based primarily on NRC's guidance for performing cost-benefit analysis, i.e., NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997b). The guidance involves determining the net value for each SAMA according to the following formula:

$$\text{Net Value} = (\text{APE} + \text{AOC} + \text{AOE} + \text{AOSC}) - \text{COE}$$

where,

APE = present value of averted public exposure ($)
AOC = present value of averted offsite property damage costs ($)
AOE = present value of averted occupational exposure costs ($)
AOSC = present value of averted onsite costs ($)
COE = cost of enhancement ($).

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. Dominion's derivation of each of the associated costs is summarized below.

Averted Public Exposure (APE) Costs

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δperson-rem/year)
x monetary equivalent of unit dose ($2,000 per person-rem)
x present value conversion factor (10.76 based on a 20-year period with a 7-percent discount rate).

As stated in NUREG/BR-0184 (NRC 1997b), it is important to note that the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, Dominion calculated an APE of approximately $275,900 for the 20-year license renewal period, which assumes elimination of all severe accidents.

Averted Offsite Property Damage Costs (AOC)

The AOCs were calculated using the following formula:

AOC = Annual CDF reduction
x offsite economic costs associated with a severe accident (on a per-event basis)
x present value conversion factor.

For the purposes of initial screening, which assumes all severe accidents are eliminated, Dominion calculated an annual offsite economic risk of about $21,800 based on the Level 3 risk analysis. This results in a discounted value of approximately $234,700 for the 20-year license renewal period.

Averted Occupational Exposure (AOE) Costs

The AOE costs were calculated using the following formula:

AOE = Annual CDF reduction
x occupational exposure per core damage event
x monetary equivalent of unit dose
x present value conversion factor.

Dominion derived the values for averted occupational exposure from information provided in Section 5.7.3 of the regulatory analysis handbook (NRC 1997b). Best estimate values provided for immediate occupational dose (3300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $2,000 per person-rem, a real discount rate of 7 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes all severe accidents are eliminated, Dominion calculated an AOE of approximately $11,000 for the 20-year license renewal period.

Averted Onsite Costs (AOSC)

Averted onsite costs (AOSC) include averted cleanup and decontamination costs and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. Dominion derived the values for AOSC based on information provided in Section 5.7.6 of the regulatory analysis handbook (NRC 1997b).

Dominion divided this cost element into two parts — the Onsite Cleanup and Decontamination Cost, also commonly referred to as averted cleanup and decontamination costs, and the replacement power cost.

Averted cleanup and decontamination costs (ACC) were calculated using the following formula:

ACC = Annual CDF reduction
x present value of cleanup costs per core damage event
x present value conversion factor.

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in the regulatory analysis handbook to be $1.5 billion (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension. For the purposes of initial screening, which assumes all severe accidents are eliminated, Dominion calculated an ACC of approximately $334,400 for the 20-year license renewal period.

Long-term replacement power costs (RPC) were calculated using the following formula:

RPC = Annual CDF reduction
x present value of replacement power for a single event
x factor to account for remaining service years for which replacement power is required
x reactor power scaling factor

Dominion based its calculations on the value of 1154 megawatts electric (MW[e]). Therefore, Dominion applied power scaling factor of 1154 MW(e)/910 MW(e) to determine the replacement power cost. For the purposes of initial screening, which assumes all severe accidents are eliminated, Dominion calculated the RPC to be approximately $288,600.

Using the above equations, Dominion estimated the total present dollar value equivalent associated with completely eliminating severe accidents at MPS3 to be about $1,145,000.

Dominion's Results

The total benefit associated with each of the 52 SAMAs evaluated by Dominion is provided in Table I-3. These values were determined based on the above equations for the various averted costs together with the estimated annual reductions in CDF and population dose, and then increased by a multiplier of 1.6 to account for additional risk reduction in external events. The values for total benefit reported in Table I-3 include this multiplier. As a result, all SAMAs that were evaluated were eliminated because the cost was expected to exceed the estimated benefit.

In response to an RAI regarding the costs of SAMA 112 (proceduralize local manual operation of AFW when control power is lost), Dominion assessed the applicability/feasibility of a procedure for manual operation of the turbine-driven AFW (TDAFW) pump when control power is lost, similar to that in place at MPS2. Dominion stated that this SAMA would likely require a plant modification to provide the level indication that would be necessary during SBO, in addition to a new procedure. However, Dominion stated that if this SAMA can be accomplished via a SAMG, without a hardware modification, then the SAMA would be cost-beneficial and will be implemented prior to the period of extended operation (Dominion 2004b).

I.6.2 Review of Dominion's Cost-Benefit Evaluation

The cost-benefit analysis performed by Dominion was based primarily on NUREG/BR-0184 (NRC 1997b) and was conducted in a manner consistent with this guidance.

In order to account for uncertainties in the cost estimates, Dominion applied a factor of two margin in assessing whether SAMAs were cost-beneficial, i.e., a SAMA was considered to be cost-beneficial if the total benefit is within a factor of two of the estimated cost. The staff asked the applicant to consider the impact of uncertainty in the CDF (NRC 2004). In response, Dominion stated that CDF uncertainty calculations are not available in the current version of the Millstone PRA model. However, based on a review of recent SAMA analyses in support of license renewal, the 95th percentile CDF ranged from a factor of 2.0 to a factor of 6.4 greater than the mean CDF. Dominion stated that in order to provide conservatism, it compared the

cost to twice the calculated benefit. Dominion further indicated that most of the benefit calculations were performed in a bounding fashion, i.e., the SAMA is completely effective, and that such estimates would be substantially less if a more realistic analysis were performed for each SAMA (Dominion 2004b).

The staff questioned the approach of increasing the benefit (based on internal events) by 60 percent to account for external events (NRC 2004). In response to the RAI, Dominion stated that a multiplier of 1.6 was used because the external events analyses are not readily quantifiable (Dominion 2004b). The use of a multiplier on the benefits obtained from the internal events PRA to incorporate the impact of external events makes the implicit assumption that the consequences from external events sequences are the same as the consequences from internal events sequences. To demonstrate the robustness of the analysis, Dominion performed a sensitivity study that increased the assumed contribution from external events from 60 percent to 120 percent of the internal event benefits. The result was that the increased benefit exceeded the lower bound of the cost estimate range for only 2 SAMAs (112 and 168). Dominion stated that external events are dominated by LOOP and SBO (approximately 85 percent of the external events CDF comes from SBO). SAMA 168 (automate feed and bleed) would have no benefit for SBO sequences because feed and bleed cannot be achieved without power. Additionally, this SAMA could create additional means for a spurious power-operated relief valve opening or safety injection (a negative benefit). Therefore, Dominion concluded that the use of the 1.6 multiplier is acceptable. SAMA 112 is discussed further below.

Dominion assessed the impact of other factors on the analysis results, such as the contribution of external event initiators that were not explicitly included in the MPS2 risk profile, the use of a 3 percent discount rate as compared to the 7 percent discount rate used in the baseline calculations, as well as a 15-percent real discount rate (Dominion 2004a). These sensitivity cases resulted in an increase in the benefit calculation of about 30 percent or less. These analyses did not change Dominion's conclusion that none of the candidate SAMAs would be cost-beneficial except as noted above. In addition, Dominion performed sensitivity analyses that addressed assumptions made in other parts of the cost-benefit analysis, including meteorological data, source term, and evacuation. Dominion also considered the sensitivity to the impact of current and future fuel management practices. These sensitivity cases are generally bounded by the 3-percent discount rate sensitivity study.

The staff notes that accounting for each of these factors would tend to increase the benefit as compared to the baseline case analysis. However, the calculated benefits used in the baseline analysis are generally overestimated and, therefore, conservative. The staff concludes that the use of the factor of two to account for uncertainties, coupled with the fact that the calculated benefits are generally conservative, provides a reasonable treatment of uncertainties and is adequate for the SAMA evaluation.

The staff questioned Dominion about lower cost alternatives to some of the SAMAs evaluated, including the use of a direct-drive diesel AFW pump (NRC 2004). With regard to the specific lower-cost alternative involving a direct-drive diesel AFW pump, Dominion stated that the alternative would not be viable at MPS3 due to room and ventilation constraints as well as costs. Dominion further stated that MPS3 has a SAMG for using the diesel fire pump to provide water to the AFW system (Dominion 2004b).

Dominion also identified and evaluated several lower-cost alternatives to those considered in the ER. These included (1) installing an unfiltered hardened containment vent, (2) using existing systems to flood the reactor cavity, (3) creating a new SAMG to direct manual control of AFW, and (4) using the fire water system to fill the steam generators. Dominion concluded that three of the alternatives are covered by an existing procedure or SAMG, or could be instituted following evaluation and guidance by the Technical Support Center. The alternative involving creation of a new SAMG to direct manual control of the AFW pump is not currently covered by an existing procedure, but is related to SAMA 112.

SAMA 112 involves physical modifications to provide steam generator level indication in an SBO scenario, as well as the development of an emergency operating procedure that would direct the manual control of the TDAFW pump (Dominion 2004b). This SAMA was estimated to have a benefit of about $43,000 and an implementation cost of about $100,000. As such, it would not be cost-beneficial. As an alternative to SAMA 112, Dominion considered the development of a SAMG without the hardware modification. This improvement could be effective in a more limited number of sequences in which auxiliary feedwater control power is lost, but steam generator level indications are not. Development of a SAMG for manual control of the pump would involve engineering to determine the feasibility, creation of the new SAMG, field verification of the actual operation, and final SAMG production. Dominion estimated the cost of this alternative to be in the range of $50,000 to $60,000. The estimated benefit of this modification (after doubling to account for uncertainty) is greater than the expected cost; therefore, it is potentially cost-beneficial. As indicated in its RAI response, Dominion plans to complete its evaluation of this SAMA and, if it is cost-beneficial, will develop a SAMG addressing manual control of the turbine-driven AFW pump prior to the period of extended operation (Dominion 2004b).

The staff concludes that, with the exception of one potentially cost-beneficial SAMA discussed above, the costs of the SAMAs would be higher than the associated benefits. This conclusion is supported by uncertainty assessment and sensitivity analyses and upheld despite a number of additional uncertainties and non-quantifiable factors in the calculations, summarized as follows:

- A factor of two was used to account for uncertainties. Even if a higher factor were considered to reflect a larger uncertainty in CDF, e.g., a factor of five, only one additional SAMA would be close to becoming cost-beneficial — SAMA 168. However, this SAMA is not expected to be cost-beneficial under more realistic assumptions regarding risk reduction and implementation costs.
- Sensitivity calculations were performed with respect to the discount rate (3 percent and 15 percent) and various MACCS2 parameters, including meteorological data, evacuation speed, evacuation delay time, and source terms. The results of these sensitivity studies showed that none of the risk benefits was increased by more than 40 percent. Since this is less than the margin between cost and benefit for the SAMAs considered, the uncertainties in these parameters would not alter the conclusions.

I.7 Conclusions

Dominion compiled a list of 185 SAMA candidates using the SAMA analyses as submitted in support of licensing activities for other nuclear power plants, NRC and industry documents discussing potential plant improvements, plant-specific insights from the MPS3 PRA model. A qualitative screening removed SAMA candidates that (1) were not applicable at MPS3 due to design differences, (2) had already been implemented at MPS3, or (3) were related to RCP seal vulnerability. A total of 133 SAMAs were eliminated, leaving 52 for further evaluation.

For the remaining SAMA candidates, a more detailed design and cost estimate were developed as shown in Table G-3. The cost-benefit analyses showed that none of the SAMA candidates was potentially cost-beneficial. Upon completion of a 3-percent discount rate sensitivity study, as well as other sensitivity studies, no additional SAMA candidates were determined to be potentially cost-beneficial. To account for uncertainties, Dominion compared the cost of the SAMA with twice the calculated benefit. As a result, no additional SAMAs were cost-beneficial.

The staff reviewed the Dominion analysis and concluded that the methods used and the implementation of those methods was sound. The treatment of SAMA benefits and costs, the generally large negative net benefits, and the inherently small baseline risks support the general conclusion that the SAMA evaluations performed by Dominion are reasonable and sufficient for the license renewal submittal. The unavailability of an external event PRA model precluded a quantitative evaluation of SAMAs specifically aimed at reducing risk of external event initiators; however, improvements that have been realized as a result of the IPEEE process and the inclusion of a multiplier to account for external events would minimize the likelihood of identifying cost-beneficial enhancements in this area.

Based on its review of the Dominion SAMA analysis, the staff concurs that none of the candidate SAMAs are cost-beneficial, except for SAMA 112 — proceduralize local manual operation of AFW when control power is lost. This is based on conservative treatment of costs and benefits. This conclusion is consistent with the low residual level of risk indicated in the MPS3 PRA and the fact that MPS3 has already implemented many of plant improvements identified from the IPE and IPEEE processes. Although SAMA 112 may be cost-beneficial if it can be implemented via procedural enhancements, this SAMA does not relate to adequately managing the effects of aging during the period of extended operation. Therefore, it need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

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11. ABSTRACT *(200 words or less)*

This final supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted to the NRC by Dominion Nuclear Connecticut, Inc. (Dominion) to renew the operating license for Millstone Power Station, Units 2 and 3 (Millstone) for an additional 20 years under 10 CFR Part 54. The final SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the staff's recommendation regarding the proposed action.

The NRC staff's recommendation is that the Commission determine that the adverse environmental impacts of license renewal for Millstone are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by Dominion; (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments.

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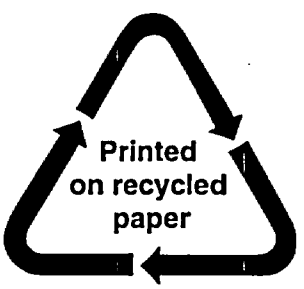

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