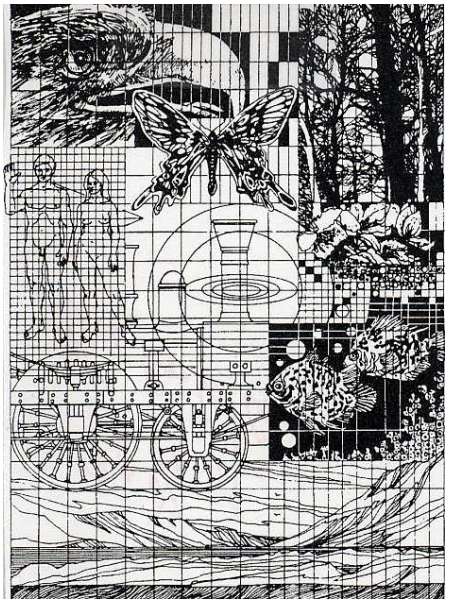

An Electronic Newsletter of EEA's Environmental Consulting Activities
Spring 2004

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Environmental Consulting

INSIGHTS

SUBSTRATUM INTAKE SYSTEM
An Innovative Water Intake System for Power Generation Facilities

Overview of the Concept

Under the guidance and direction of Roy R. Stoecker, Ph.D., Vice President of EEA, staff scientists and engineers conceived a substratum intake structure technology that may have widespread beneficial ramifications upon both the operations and environmental impacts of large thermal power plants.

The acronym SIS stands for "Substratum Intake System." The SIS Concept replaces traditional surface water intake structures with an under sea bottom (or lake bottom) well field utilizing surface waters filtered through a natural sand bed. The objective of the Concept is to allow facilities to operate open cycle cooling systems without causing impacts to the indigenous biota.

Roy R. Stoecker, Ph.D.
Vice President, EEA
Inventor of the SIS Concept

Steam electric generating stations (or other industrial facilities) that utilize ambient surface waters for cooling the condensers produce a variety of negative environmental impacts to the local receiving waters.

The massive volumes of water circulated through a large facility absorb heat from the condensers typically raising the water temperatures 10 to 20 degrees within seconds. Additionally, facilities situated on saline waters periodically use biocides, such as chlorine to control the growth of algae and attaching organisms.

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EEA services include Phase I ESAs, Haz-Mat Testing and Remediation, Wetlands Delineation and Creation, Natural Resources Inventories, Marine Ecology Studies, Air Quality and Noise Studies, and Environmental Management System (ISO 14000) Implementation.

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Types of Environmental Impacts From Traditional Intake Structures

Entrainment

Entrainment is a term for the process of sweeping planktonic organisms, including fish eggs and larval forms, through the cooling system of a power plant. The organisms are subject to mechanical (pumping) stresses, thermal effects and injection of biocides. Overall mortality of the organisms varies but is usually high, sometimes approaching 100 percent. This mortality is thought to be a factor in reduction of finfish stocks in both fresh and saline waters.

Impingement

The term impingement refers to the process whereby fish and invertebrates are sucked against the intake screens of a power plant. The water velocity prevents them from getting off the screens and they remain there until the screens are backwashed. Impinged fish and invertebrates are sometimes returned alive to ambient waters, but can be killed.

Northeast Coast Power Plant

Thermal Plumes

Discharge water from power plants is usually 15 to 25 degrees higher than the intake water. Depending on the water demands of the plant, large thermal plumes of heated water may exist in the vicinity of the power plant or other heat producing industrial facility. During summer months, these plumes may be sufficiently hot to kill or stun fish and invertebrates.

SIS Concept

While much work has been done researching the effects of power plants on aquatic biota, and numerous intake systems tested, the impacts still remain very much a problem. So much so that regulatory agencies usually specify an alternate cooling system, such as cooling towers, even though this lessens the thermal efficiently of the power plant or industrial facility. Over the past several years, EEA scientists and engineers have conceived of an alternate cooling system for thermal plants that retains the advantage of ambient water cooling while completely eliminating all adverse environmental impacts.

Power Plants-Water Permitting
Glenn Piehler, Ph.D.

Envrionmental Management Systems (ISO 14000)
Robert Clifford

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Founded in 1979

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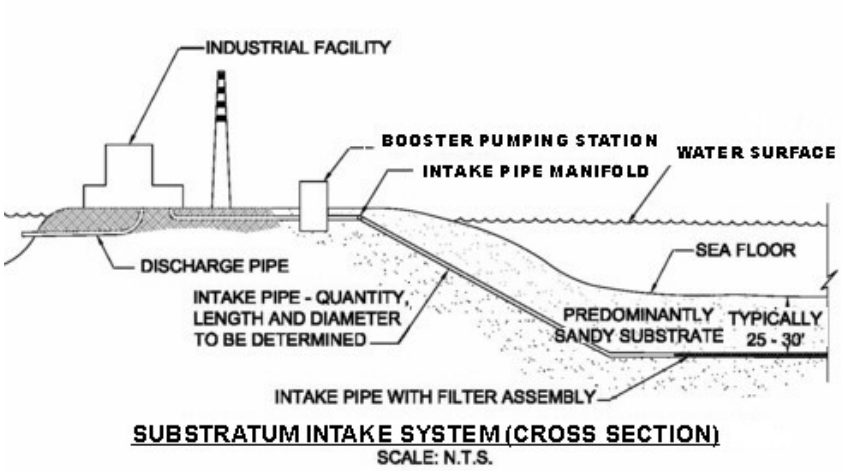
Historical USEPA "Guidance" for Once Through Cooling Water Intake Systems (CWIS)

- Avoid wetlands, threatened and endangered species habitat
- Avoid lagoons, coves, etc.
- Keep the screen approach velocity below 0.5 feet per second (fps)
- Avoid "downdrafts" into CWIS (incorporate velocity caps)
- Minimize the time organisms are pinned against screens
- Don't put a high capacity intake in a zone of high biological value



Conceptual Diagram of SIS, the Substratum Intake System

No Entrainment
Instead of using surface waters, the proposed SIS intake system uses ground water from under the surface water body. Assuming a medium to coarse sand substrate, a series of horizontal well heads is drilled from the shore to a terminal point offshore. The well screens will be approximately thirty feet below the sea floor bottom. Water reaching the well screens will be filtered through this sand, which will completely eliminate the planktonic organisms so no entrainment of these forms will result.

No Biocides
Since the ground water reaching the plant is essentially sterile, there will be no need for biocides for encrusting organisms. The elimination of biocide injection is an environmental benefit for the system and a cost-saving measure as well.

No Impingement
Additionally, assuming the well field is sufficiently large in area, the downward velocity gradient through the sand sea floor will be so low as to preclude any possibility of impingement of organisms on the sea floor above the well field.

No Thermal Plume
Since the ground water underneath the surface waters is too deep to experience seasonal thermal variations, it remains at near constant temperature year round. For this region (Long Island, New York), that temperature is approximately 50 degrees. Assuming a power plant temperature rise of 20 degrees, the release temperature during summer months will be 70 degrees, or approximately five degrees below summer ambient for this area. Therefore, there will be no thermal plume coming from a power plant with an SIS cooling system. Thermal plumes are not considered detrimental during winter months.

Substantial Thermal Efficiency Gains (Fuel Savings)
Since the summer substrate intake water will be cooler than ambient surface waters, the SIS concept will improve the thermal efficiency of

EPA's Key Milestones for Revised 316(b) Regulation since 1995

- ✓ 1/98 – Information Collection Request (ICR) issued
- ✓ 6/98 – First public hearing (approach)
- ✓ 9/98 – Second hearing (cost benefits, mitigation)
- ✓ 7/00 – Proposed Phase I Regs (new CWIS)
- ✓ 5/01 – "Panel of Experts" Conference
- ✓ 11/01 – Final Phase I Regs
- ✓ 2/02 – Proposed Phase II Regs (existing power plant CWIS)
- ✓ 5/03 – Meeting on technologies
- ✓ 2/04 – Final phase II Regs issued
- ✓ 11/04 – Proposed Phase III Regs due (other facilities with CWIS)
- ✓ 6/06 – Final Phase III Regs due

See Winter 2004 edition of ***INSIGHTS***

EEA's SIS Is Expected to Address 316(b) Requirements

a power plant during the peak demand months. The SIS concept, if implemented, will impose no parasitic drag on the operations of a power plant and, in fact, may boost thermal efficiency during summer months. If compared to a cooling tower alternative, the SIS concept will have even greater thermal efficiency benefits.

This increase in thermal efficiency will result in substantial fuel savings for the plant. Preliminary calculations by thermal power plant engineers reveal that, for a large electric plant, fuel savings would be in the multimillions per summer season.

The physical concept is broken into three component pieces:

- Under sea or lake bottom well field. Well screen pipes are buried by horizontal directional drilling under the sea bottom to a depth of approximately thirty feet. The length and diameter of the well field pipes will depend on the water quantity required by the particular facility. A sand substrate (as opposed to rock or clay) is a requirement for the SIS concept.

- Manifold and pumping station. The substrate well pipes are connected to a collection manifold and then to a booster pump station that pumps the water from the collection pipes to the shoreside facility.

- Water collected by the SIS and pumped into the power plant will be fed directly into the plant forebay where the circulating pumps will operate normally. The forebay will be closed to surface water by stop logs, but could quickly be reopened if needed. This gives the plant complete redundancy for cooling supply.

Current Status

In September 2003, EEA retained a patent attorney firm. They researched the proposal and found that no prior patent had been issued for the Substratum Intake System concept. Based on that finding, and the opinion of the attorneys that the proposal is patentable, an application was filed with the United States Patent Office. The present concept is considered patent pending.

In order to further develop the system, EEA has assembled a team consisting of a hydrogeological firm and an engineering firm with extensive experience in water well technologies. EEA scientists are in negotiations with utilities concerning feasibility projects and conceptual engineering designs for specific power plants. EEA scientists are also presenting the concept to regulatory agencies and electric utility trade associations. Since the USEPA has recently issued Phase II regulations for existing power plants (CWIS) (see previous *Newsletter)* that require substantial reductions of entrainment and impingment, the SIS concept is particulary timely. For further information email to: rstoecker@eeaconsultants.com