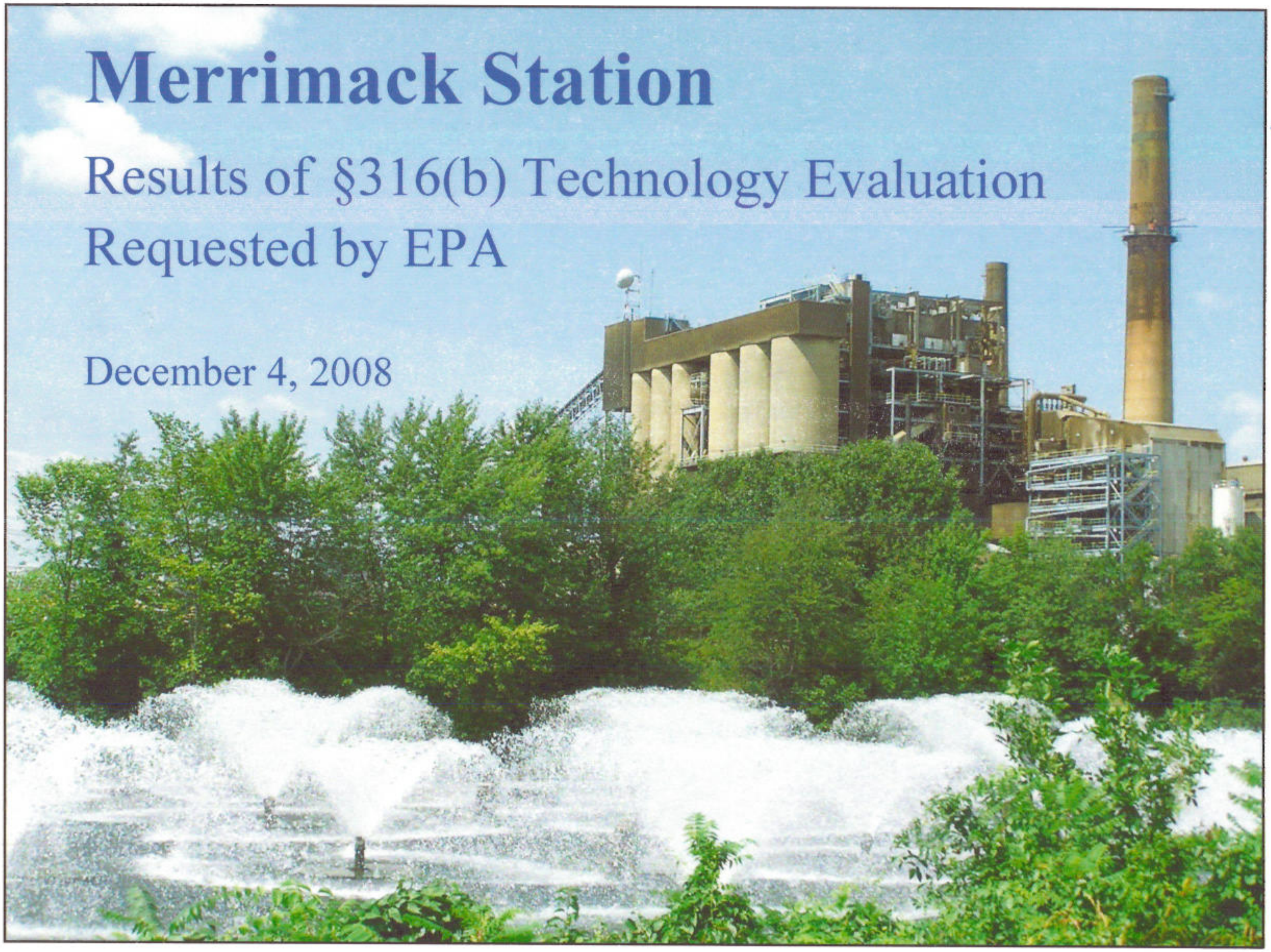
Merrimack Station
Results of §316(b) Technology Evaluation
Requested by EPA
December 4, 2008

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Objectives of §316b Technology Evaluation

- Identify technologies that would be both technologically feasible at Station and commercially available or precedented
  - Potential Technologies Evaluated for Maximizing Entrainment Reductions
    - Flow Reductions
    - Fine Mesh Screening Technologies
  - Potential Technologies Evaluated for Maximizing Impingement Reductions
    - Fish Handling Technologies
    - Coarse Mesh Screening Technologies
    - Approach / Thru-Screen Velocity Reductions
    - Flow Reductions
  - Cooling Towers – Why Not?
    - Implementation Uncertainties
    - Adverse Impact on Station Output
    - Adverse Impact on Station Ability to Maintain Reliable Power Supply to Grid
    - Adverse Impact on Carbon Emissions

Technologies Evaluated to Maximize Entrainment Reductions - 1

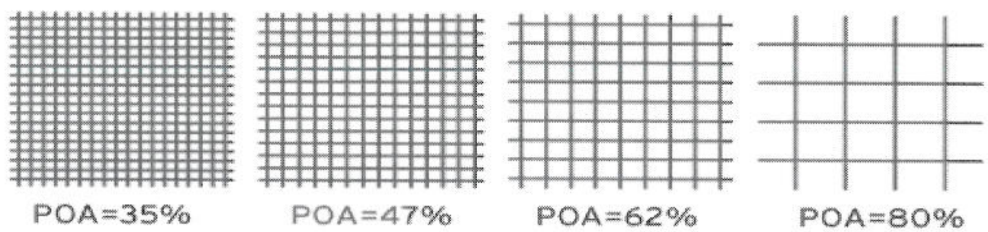
Flow Reductions

- Variable Speed Pumps/Pump Operational Measures
  - Flow reductions limited by condenser design
    - Unable to achieve significant reductions in entrainment
- Plant Outages (Planned)
  - Maintenance outage scheduling
    - Current outages scheduled to occur in spring and fall
    - Rescheduling Unit 2 spring outage to begin in mid-May could potentially reduce total Station entrainment by 27%
- Cooling Towers at Both Units
  - Theoretical entrainment reductions of 96%
  - Numerous negative impacts (discussed later in presentation)

Technologies Evaluated to Maximize Entrainment Reductions - 2

Fine Mesh Screening Technologies

- Traveling Screens
  - Implementation limited by intake configuration
    - Fine Mesh requires greater screening area due to reduced effective area (i.e., the finer the mesh, the lower the percent open area)



    - Neither intake has sufficient area for larger traveling screens necessary to maintain appropriate thru-screen velocity. Modified or new intakes would be extremely expensive and intrude significantly into the river.
    - Frazil ice issues remain even if new intakes were constructed

Technologies Evaluated to Maximize Entrainment Reductions - 3

Fine Mesh Screening Technologies

- Wedgewire Screens
  - Provides significant theoretical entrainment reductions
  - Infeasible at Station due to frazil ice blockage
    - Per vendor recommendation, station with intake that has history of frazil ice should not consider installing wedgewire screens
    - Vendor recommendation supported by evidence from Army Corps of Engineers paper entitled "Frazil Ice Blockage of Intake Trash Rakes"
- Gunderboom
  - River navigation barrier
  - Silt fouling
  - Shallow river depth mandates large size

Technologies Evaluated to Maximize Impingement Reductions - 1

Fish Handling Technologies

- Upgraded Fish Return System
  - Existing fish return system is dated
  - Newer designs could offer significant reductions in impingement mortality
- Continuous Operation of Traveling Screens
  - When coupled with upgraded fish return system, continuous operation could potentially provide estimated 47% reduction in impingement mortality
  - Can be utilized with existing traveling screens, potentially upgraded with fish buckets

Technologies Evaluated to Maximize Impingement Reductions - 2

Coarse Mesh Screening Technologies

- Coarse Mesh Ristroph Screens, Multi-Disc Screens, WIP System
  - Impingement reductions similar to those achievable by continuous operation of existing screens with upgraded fish return system
- Dual Flow Conversion Traveling Screens
  - Dual flow screens are physically larger than existing through-flow screens due to screen configuration
  - New intake designs or extensive modifications to existing intakes would be required
- Wedgewire Screens
  - Presumed infeasible due to frazil ice blockage

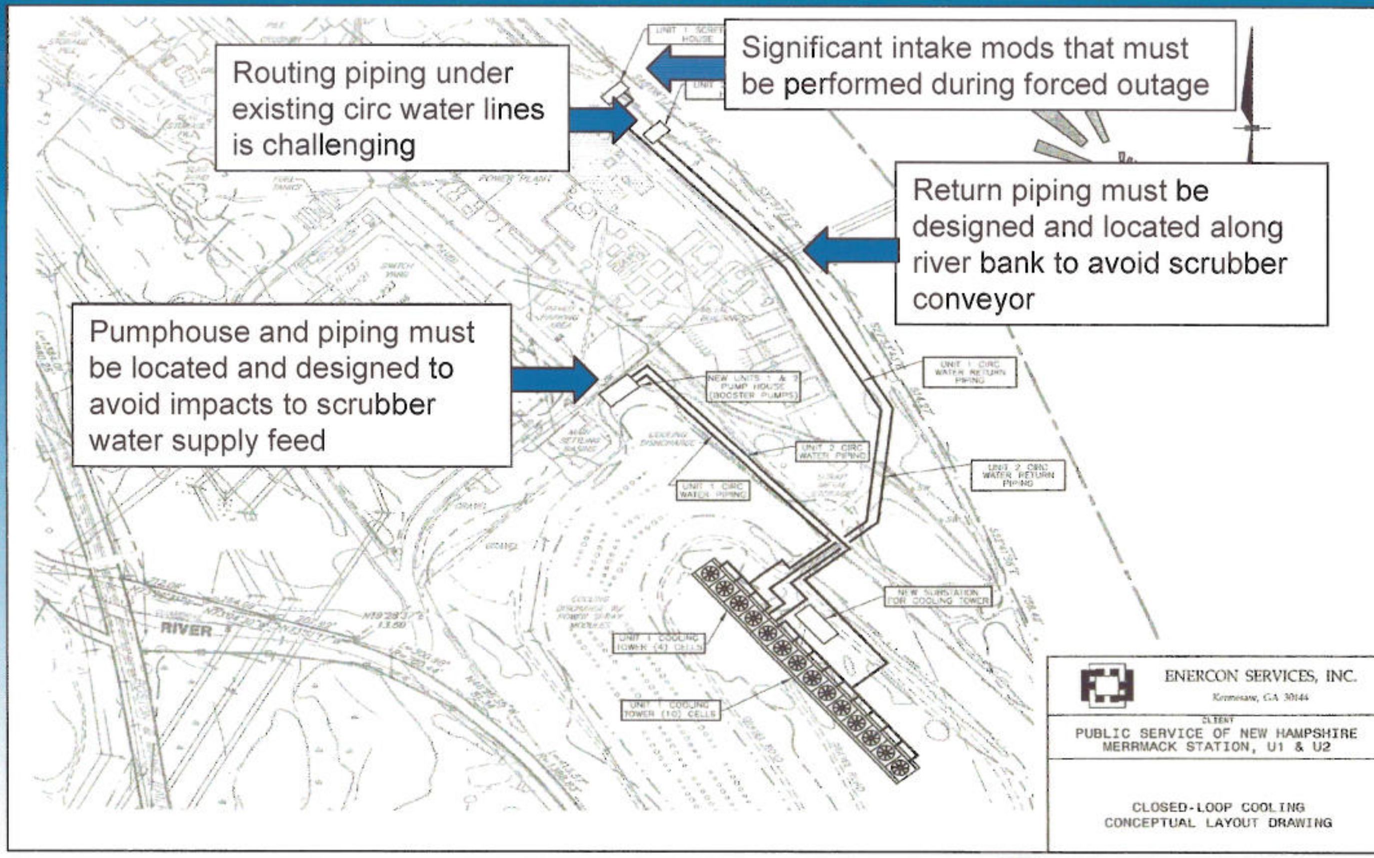
Technologies Evaluated to Maximize Impingement Reductions - 3

Approach / Thru-Screen Velocity Reductions

- Increase Existing Open Screen Area
  - Dual Flow Screens
    - Configuration of existing intakes cannot accommodate dual flow screens
  - Wedgewire Screens
    - In theory, would provide significant velocity reductions
    - Infeasible due to frazil ice blockage
  - Through Flow Screens (Fine and Coarse Mesh)
    - Would provide no reduction to approach / thru-screen velocity

Cooling Towers – Why Not?

– Implementation Uncertainties



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Cooling Towers – Why Not? - 2

Adverse Impacts on Station Output

- In order to maintain station output, inlet cooling water temperatures near current levels are required due to condenser design
- Closed-loop cooling with cooling towers rejects portion of heat load to atmosphere, but recycles remaining heat back to Station through increased inlet cooling water temperatures
- Increased inlet cooling water temperatures would result in condenser efficiency losses, increased fuel consumption, significant load reductions, and potentially Unit 1 shutdown

Cooling Towers – Why Not? - 4

Adverse Impact on Carbon Emissions

- Condenser inefficiencies result in lost power at Station, requiring replacement power that produces additional carbon emissions

- Increased fuel consumption at higher inlet water temperatures results in direct increase of carbon emissions at Station

- Boiler limitations may result in unexpected Station outage during peak summer months, requiring replacement power that produces additional carbon emissions

Cooling Towers – Why Not? - 6

Station Efficiency Losses

- Increased fuel consumption
  - Due to varying operating conditions, coal consumption by Station varies by approximately 50,000 lbs/hr at design power
  - Warm condenser inlet water discharged from cooling towers would increase inefficiencies, requiring increased fuel consumption
  - Station is extremely boiler limited, effectively capping fuel consumption variability at 50,000 lbs/hr. Any increase in fuel consumption beyond this point would not result in increase in megawatt output.

Cooling Towers – Why Not? - 7

Station Reliability Impacts

- Cooling towers introduce additional failure modes and reliability/maintenance issues

Plume Impacts

- Plumes reduce visibility and cause roadway icing, both potential safety concerns for nearby roads and highways, i.e., heavily traveled Interstate 93 and Route 3A
- Plume deposition and moisture content degrade ancillary Station equipment and impact local vegetation
- Aesthetic impacts to river traffic and nearby residential areas

Cooling Towers – Why Not? - 8

Noise Impacts

- Cooling towers produce relatively high levels of constant noise, often above local zoning acceptable levels
- There are existing noise issues with residential areas across river that may be exacerbated by addition of cooling towers
- Sound attenuation is available for cooling towers at significant increase to capital cost

Water Consumption

- Unlike current Station operation, cooling towers evaporate river water as primary mode of heat rejection
  - Unit 1 river water loss: approximately 1.4 MGD
  - Unit 2 river water loss: approximately 3.4 MGD

Proposed BTA for Merrimack Station

- Associated Biological Benefits from Proposed BTA for Merrimack Station
  - No increase in carbon emissions
  - No increase in consumption of river water
  - Potential impingement reductions from baseline
    - Estimated 60% reduction in impingement for Unit 1
    - Estimated 72% reduction in impingement for Unit 2
  - Potential entrainment reductions from baseline
    - Estimated 19% reduction in entrainment for Unit 1
    - Estimated 51% reduction in entrainment for Unit 2