Hallam-ICS

ENGINEERING

CONTROL SYSTEMS INTEGRATION

COMMISSIONING & QUALIFICATION

Evergreen Solar

Noise Mitigation Report
and
Proposed Short Term Solutions

Prepared For:
Devens Enterprise Commission
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Background

Hallam-ICS has been retained by DEC to assess noise mitigation measures currently planned for the Evergreen Solar plant located at 112 Barnum Road in Devens. These measures are planned in response to complaints by residents located adjacent to the Evergreen Solar facility.

The facility produces solar panels and as such contains processes that produce toxic waste. Some of these are airborne and require mitigation before being discharged to the atmosphere. In addition, the plant includes process and environmental cooling requirements that require mechanical cooling systems. Studies have been commissioned by Evergreen Solar and by DEC in an effort to identify sources and to establish specifications to bring the facility into conformance with local noise regulations. The original analysis was included in the facility design documents prepared by CH2MHILL. Subsequent to this, Modeling Specialties of Westford, MA performed analysis of existing conditions and the effectiveness of proposed measures.

Solutions have been proposed by CH2MHILL. Evergreen has begun instituting these measures for the mitigation of noise at the facility. Some temporary measures have been taken while equipment been ordered for permanent measures are installed.

This report focuses on equipment contributing to Tier 1 noises. Equipment operational characteristics are reviewed to identify possible modifications that will reduce noise generated by the equipment. Much of the equipment operation is dictated by production process requirements. For the purpose of this report, these requirements are considered fixed.

Processes

Tier 1 noises include:

- Process Gas Filling Station
- VOC Combustion and Exhaust Blowers
- ASX Exhaust Stack Outlet
- Cooling Towers

Process Gas Filling Station

Bulk gas deliveries are made throughout the day. The pumps are producing sound at levels requiring mitigation. This involves pumping of the liquefied gases at high pressure from the truck to the facility tanks. Evergreen has attempted to reduce the delivery pressure but this provided minimal benefit. This also reduced the tank capacities, thereby requiring more frequent filling. A sound absorbing wall has been erected as a temporary solution. The plan for a permanent solution is to install ground mounted pumps in an acoustical enclosure. If properly designed this should provide sufficient attenuation to reduce noise to acceptable levels.

Operational Issues

- The current setup with temporary sound attenuating screen appears to be working well enough until a permanent solution is installed. Delivery schedule are limited to working hours.

VOC Combustion and Exhaust Blowers

Manufacturing processes are producing VOC gases that require treatment before being discharged to the atmosphere. This process involves a thermal reaction in a combustion chamber ventilated by fans. The products of combustion are then discharged to the atmosphere via exhaust fans and exhaust stacks. The three sources of noise from the VOC treatment system are the combustion fans, exhaust fans and the exhaust stack outlets. There are three VOC treatment systems. Two are currently in operation and the third is expected to be online in one month. The two systems in operation are currently running without interruption.

Evergreen have indicated that both systems online are needed to satisfy current production rates. Evergreen conducted a test to determine whether production could stop so that the systems could be shut down during the night but found that the combustion blowers needed to remain on for a period in excess of 8 hours to cool down process ovens. Unless manufacturing process changes can be made there is little that can be done to reduce noise generated by the VOC systems while manufacturing processes they serve are in operation.

Suggested Measures

- The support structure for the VOC systems could be used to drape acoustical blankets around the combustion fans. In addition, a blanketed structure might be able to be assembled from the catwalk at the exhaust discharges.
- Run all 3 VOC systems as soon as the third system is available.
- Schedule VOC dependant processes with sufficient downtime to allow periods of inactive VOC system operation.
- If the individual VOC systems are not on a common exhaust main, consider cross connecting them to allow diversification in operation.
- Inlet conditions at combustion fans are likely causing significant system effect. This will cause fan to run at higher power level, increasing sound output.
- Bypass at exhaust fan inlet could be attenuated if this is a contributing noise source.
- Design documents stated that the combustion fans utilize intake dampers for capacity modulation. This will cause fan noise to be high at lower capacity operation. If the inlet damper were removed and replaced with a VFD, noise would be reduced at part load operation.
- Consider adding door seals on the production cabinets to reduce exhaust flow requirements.

Operational Issues

- Production service requirements make it difficult to periodically shut down the VOC equipment. Shutting down a thermal reactor requires that the combustion fan continue to run for a minimum of 8 hours to cool the ovens.

ASX Exhaust Stack

Some manufacturing processes use acids. The residual vapors require recapture and disposal. In addition, the chemical bunker is exhausted by the ASX system. Concentrations of contaminants in the exhaust stream are higher from the process equipment than from the bunker. Cleanup of the exhaust stream is accomplished in a scrubber, which includes exhaust fans and stacks. Volume of exhaust is dictated by process requirements at the production equipment. The exhaust volume of the bunkers (2) is dictated by the volume of the space itself. Evergreen are currently installing gas monitors in the bunkers in an effort to reduce exhaust.

The bunker was constructed without a ceiling, effectively doubling the room volume. There is a support structure about 15 above the floor that is carrying some services. It maybe possible to install a ceiling above this structure to reduce the room volume. In addition, doors from the dock to the bunkers was left open. This has the effect of increasing the room volume and reducing the exhaust system effectiveness.

Suggested Measures

- Keep door closed and consider a ceiling to be able to reduce exhaust volume in the bunkers.
- If the contaminants are sufficiently low in the bunker exhaust stream, consider separating this exhaust from the main ASX exhaust system. This would require quantification of the concentration and may require filtering before discharge, depending on code compliance.
- Consider adding door seals on the production cabinets to reduce exhaust flow requirements. Process equipment manufacturers should be consulted to verify acceptable operating conditions.

Operational Issues

- A ceiling in the bunker would limit access to services above. ASX remediation equipment may not be able to operate at the reduced flow rates. Building ventilation systems would need to be rebalanced.

Cooling Towers

The cooling towers reject heat from condenser water (CW), which is used to cool all thermal processes in the plant, including the chillers used to produce chilled water (CHW), and furnace cooling water (FCW) used to cool the furnaces. Nine open cell cooing towers, 5 for Phase 1 and 4 for Phase 2 are currently installed with a total capacity of 6,600 T and are equipped with variable speed drives. Space is available in the Phase 2 installation for one additional tower, which will bring the total capacity to approximately 7,300 T. The towers are designed to cool CW from 80F to 70F. The configuration is set up such that the Phase 1 and Phase 2 towers run on separate systems. Evergreen indicated that the towers are running at a total of about 3,000 T capacity and that the load is fairly consistent throughout the week.

The chillers are used for space cooling and for process cooling. The CHW supply and return temperatures are 43F and 55F. The CW supply and return temperatures in the chillers are 70F and 80F. The chiller specifications list supply and return temperatures of 80F and 90F. This would indicate that it may be possible to increase the operating temperature of the CW and still satisfy the chiller requirements. There are 3 chillers in the Phase 1 system, each with a capacity of 1,000 T, and 2 chillers in the Phase 2 system with room for one more. The 2 systems are separate.

CW is also used in a heat exchanger to produce FCW. Two heat exchangers are installed, one duty and one standby. Specifications for the FCW are 80F and 90F. This allows a 10 degree temperature difference between the CW and FCW. The heat exchangers are specified at a 10 degree difference between the CW and FCW. Design drawings indicate that FCW makes up about 20% of the cooling tower capacity, assuming one heat exchanger is used.

Cooling tower performance is dependent on the ambient wet bulb temperature. Towers typically require ambient wet bulb temperature to be at least 5F below the supply CW temperature. Therefore, to provide 70F CW, the ambient wet bulb temperature must be no more than 65F. Local weather data indicates that there will be significant periods of time when the wet bulb temperature is above 65F. What this means to Evergreen is that the CW plant will not be able to maintain design conditions during these periods. There are a number of operational issues related to this but for the purposes of this report, we will limit the discussion to the operational consequences as they relate to equipment loads and generated sound.

The cooling towers must work harder to maintain design CW supply temperature as the ambient wet bulb temperature approaches the CW supply temperature. As this happens, the tower capacity is reduced and the fans run harder, generating more noise. The current load on the Evergreen towers is about 50% of capacity. This will increase as ambient temperatures rise. Wet bulb temperatures are typically high in July and August so cooling tower noise can be expected to increase in the short term.

Evergreen tried to reduce the load on the towers by increasing the space temperature in the plant and by raising the CW temperature in the FCW heat exchangers. Results were less than optimal. Raising the temperature in the plant elicited complaints from workers related to uncomfortable conditions. Evidently this was because many people work in protective clothing and require lower room temperatures to be comfortable, especially when working near heat producing equipment. The towers are currently be run in parallel, with 2 units set at 60% and the others allowed to modulate as necessary.

The elevated CW temperatures also caused problems at the FCW heat exchangers. When the CW supply temperature was raised to 72F the FCW supply temperature climbed to 81.5F at which time the furnace controls began to alarm. An attempt was made to increase the CW flow to the heat exchangers but this did not help. From this we can conclude that the FCW heat exchangers require 70F CW supply temperature to maintain 80F FCW temperature and provide sufficient furnace cooling capacity. Phase 1 and 2 each have 2 FCW heat exchangers. One is supposed to be redundant but Evergreen have found that both are required to provide sufficient capacity.

Sound mitigation at the tower intake can be accomplished by fitting attenuators, as has been done on the Phase 2 towers at Evergreen. Sound mitigation of low frequency sound in open cell cooling tower discharge openings is not easy. The openings are relatively large and the fan is located at the discharge opening. Attenuation devices are relatively short and do not attenuate the low frequencies well. They also constrict the discharge opening and cause the fans to work harder, sometimes negating any benefit from the attenuator.

Suggested Measures

- The towers are fitted with quiet fans. In the short term, install ultra quiet fans on the cooling towers. Install sound attenuation on the last Phase 1 tower, which does not have a Phase 2 tower in front of it.
- Towers are already set to operate together at part load. As temperatures rise, this will not hold and the towers will need to run harder. Sound absorbing screening is probably the easiest method to mitigate discharge sound until a permanent solution is found.
- The CW loop for the FCW is currently set up in parallel with the Chiller CW loop. If the FCW loop return was moved from the tower return to the chiller CW supply, the CW flow would be reduced and the towers would run more efficiently. This could be of benefit as a long term change. These changes would need to be discussed with the chiller and CW pump manufacturers.

- Add plates to the FCW heat exchangers to increase their capacity. This could allow less temperature difference between the CW and FCW so that the CW supply temperature could be reset higher. The chillers will need to be checked to make sure they will operate at the higher CW temperatures.
- Another long term solution could be to use CHW instead of CW on the FCW heat exchangers. This will solve the capacity issues at the FCW heat exchangers. It could allow the towers to operate more efficiently at higher CW temperatures. Chiller capacity may not be sufficient for this change. These changes would need to be discussed with the chiller manufacturer with regard to the higher CW temperatures.

Operational Issues

- Any modifications to the distribution systems or equipment will require well planned phasing.
- As stated above, the FCW system will not operate within its specifications when the ambient wet bulb temperature approaches 70F.