NOISE SURVEY PROGRAM TO REDUCE THE POTENTIAL IMPACT ON THE COMMUNITY SURROUNDING A LARGE OIL REFINERY

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The Valero – Jean-Gaulin Refinery is the largest oil refinery in the province of Quebec and the second largest in Canada, operating for nearly 50 years. The refinery is located in the city of Lévis with access to St Lawrence river. Built in the late 60s on predominantly rural land, several residential and commercial properties were developed, and environmental issues brought light on the importance of industrial noise management. This presentation shows the sound survey program and model the sound control measures used. Different examples of sound-emitting operations are presented to demonstrate both application of sound survey program and the mitigation actions implemented. Also demonstrated is the processes of sound data management and the communication strategy in place to report the environmental performance and keep the community informed about all the efforts put in place to minimize the impact of operations in the neighborhood. All these initiatives contribute to maintaining a harmonious cohabitation of the refinery with the community.

1. Context

The Jean-Gaulin Refinery is an oil refinery with a 265 000 BPD (barrels per day) capacity located on a site of approximately 2 km² in the City of Lévis, Quebec. The main features of the refinery are:
- Main production area;
- Tank farm;
- Tank truck loading rack;
- Pipeline terminal;
- Tank car loading rack;
- Marine terminal on St-Lawrence river.

On the refinery site, except for a single house located in front of the refinery front gate, the closest residential area is approximately 600 meters from the refinery operations.
2. Sound Monitoring

Valero’s sound monitoring program includes three (3) continuous sound monitoring stations located on two main sectors of their site. The sound is monitored 365 days per year and an automatic daily report of activities are sent to environment division each morning. In case of unusual events or activities reported by workers or communities, the environment department has sound trigger levels in place and full access to detailed history of each sound monitoring station, including camera and audio files that allow to better understand the noise behaviour and operations during past events.

Every day, the environmental engineer reviews and annotate the reports issued from the stations. When an elevated sound level is registered, further investigation is carried out with operation and maintenance teams to identify the origin of the event and evaluated any corrective actions required.

The first monitored sector is the marine terminal where the vessels are loaded or unloaded. Two (2) sound monitoring stations are located at the opposite limits of the site (Figure 1). For the most part, the survey allows for the detailing of the vessels’ noise emissions. Logs are kept, and if an unusual event occurs with a vessel, these logs can be used as a basis for comparison with the measured sound levels. It is also possible to detect particular noise events associated with pumping operations.

The second sector is associated with the flare of the refinery that is used to safely combust gases in case of process upsets (Figure 2). The noise level generated by the flare is mainly dependant on the vapour flow and this vapour flow is controlled by an automatic gas/vapor ratio. When the gas flow increases at the flare it results in a higher vapor flow, which in turn leads to a higher sound level. With this sound survey station in place, a real-time sound propagation map is made available to both the operator and the environment department to identify the noise propagation in the community (see Figures 3a and 3b). This visual tool allows for a rapid understanding of the impact of flare operation in the community and triggers a quick response to address the situation.
3. Seasonal Campaigns

Due to the site area covering ~2 km$^2$ and distances reaching 100 m, 600 m or 1.1 km between the refinery site and the first row of residences, seasonal meteorological conditions are important variables in the sound survey of activities (Figure 4). Quebec province undergoes significant changes in these conditions between seasons influencing the dominant wind patterns, the ground absorption, the vegetation (grass, leaves), and the humidity, as well as changes in operational noises due to external temperature that affect refinery processes. The sound survey campaign is conducted three times a year in spring, summer and autumn. The duration of the survey for each season is around six to ten days. The main advantage of the seasonal survey is to keep a history of soundscapes at the surrounding communities whilst considering representative emission conditions for each season. For each campaign, planning is undertaken to avoid events during irregular weather including too much rain or strong winds (over 20 km/h).
For each station, high fidelity audio tracks are recorded. During post processing of the recordings, all recorded tracks are listened to so as to filter out all transient external sound sources near the stations, leaving only the continuous sound that may come from the refinery. For example, sound source categories that should be filtered out include; local traffic, airplanes, human activities, rain, etc.

One of the goals of the seasonal campaign is to better understand the potentially continuous sound that transmits from the refinery site to the community. But it is also a good working method to better understand the external soundscape around the refinery and associated with each season.

For each campaign, a complete report is done that show the contribution of external sources and the continuous sound observed by the sound monitoring stations. With campaigns running over the last three years, it is now possible for the refinery to observe the sound evolution in the community during each season. Following this exercise, it is possible to verify that there has been no increase in acoustical emissions from the refinery over the years. Each year, the annual results are shared with the community liaison committee.

4. Noise Reduction Strategy

Some specific sources or processes may require noise reduction or abatement when it is identified that they could have an impact on community. In these cases, a detailed diagnosis is performed for each group of sources identified as problematic (Figure 5).
The main challenge encountered for sound diagnosis inside the refinery is that most of the sources are running continuously all year long, and it is not possible to stop individual sources to perform individual sound characterizations. As such, the methodology used for the detailed diagnosis is mainly focused on sound intensity, sound imagery, and sound levels measurements around the sources and the site.

Once the sound power has been characterized for each source, a 3D simulation is created using a commercial sound prediction software. Each model is calibrated using the sound pressure measurements taken around site, and by the sound monitoring stations. For the prediction software, the effects of different weather conditions such as wind, temperature and humidity, are calculated based primarily on the effects of conditions observed during the seasonal campaigns.

The development of mitigation solutions for the sources can be validated for many different weather conditions to confirm that the sound target can be respected throughout the year. An acoustical engineer works closely with refinery engineering team to help the solution design team with the acoustical aspects and performance of the solutions. The performance of the solution is then evaluated after the sound mitigation treatments are applied to confirm that the criteria has been met for all weather conditions on site.

4.1 Examples of application

One of the major noise mitigation treatments undertaken during the last few years has been the application of sound-reduction blankets for vessels that come regularly at the marine terminal (Figure 6), in tandem with implementing noise-optimized operational conditions. An acoustical program has been applied since the purchase of the vessels. Once the vessels were selected and delivered to Quebec, an advanced diagnosis was performed to address the noisiest operational sound sources. Specific areas of the vessel were covered with custom-designed sound-reduction blankets to reduce noise emissions towards the community. The implementation of the blanket solution and the identification of acoustically-optimized operation parameters were made in collaboration with the Valero operations, environment, production and engineering teams. The performance has been evaluated using discrete measurements onboard the vessels and within the community, but also via the long-term sound monitoring stations around the terminal.
5. Good practices

Additional to the monitoring programs and noise-reduction initiatives and projects, over the years Valero has implemented further measures that contribute to a better cohabitation with the community. Key measures include;

*Environmental analysis for new projects*

Each new project is subject to an evaluation by the environmental department, which assesses whether the project has the potential for increasing the sound level in the community. Whenever this is the case, noise mitigation measures are required to reduce the impact an acceptable level.

*Communication*

When it is known that a specific and predictable event (construction or maintenance activities) will have a temporary noise impact on the community, Valero communicates with the parties susceptible to be impacted and give them the appropriate information.

*Raising of awareness level*

It is part of the Valero strategic vision to keep harmonious relationship with the community and therefore each employee is informed of the importance of working in a respectfully manner to avoid creating a nuisance for neighbors.

*Complaints management*

Occasional complaints can be addressed 24h per day by contacting the helpline, where immediate verification of the complaint is carried out systematically. Immediate actions are taken to eliminate/mitigate the noise, where possible. If it is not possible to immediately address the noise, a thorough investigation is performed and corrective actions are implemented to avoid repetition. In all cases, feedback is provided to the person who complained.

*Restriction on specific vessels*

At the marine terminal, when it has been demonstrated that the sound level generated by a vessel is not acceptable, corrective actions are prompted for the vessel operator. Vessels may be subject to restrictions, which can be as severe as exclusion from entry to Valero’s terminal.

*Community liaison committee*

A community liaison committee made of different stakeholders (neighbors, MoE, municipal elected officials, environmental groups, other economic actors) meets quarterly to discuss various topics related to the refinery. Results of monitoring campaigns, complaints, and corrective actions are shared with the committee.

*Green belt*

In order to reduce the impacts of its activities on the community, Valero has pursued a property acquisition policy around the refinery and the marine terminal. In many cases, the acquired properties are kept as park and leisure areas which contribute to a buffer zone between the heavy industry and the community.
6. Conclusion

Continued residential and industrial growth has led to heavy industry and populations cohabitating closer than they use to in past decades. This can only be achieved by creating a high level of respect and trust between the parties. New acoustical technologies now help to characterize the source of noise nuisances and streamline the implementation of mitigation measures. However, receiving feedback, and acting upon it, are both key to ensuring sustainable solutions with a high acceptance rate from the local population.

With regards to noise management, the industry must demonstrate a strong commitment to maintaining a respectful sound level in order to earn its right to operate from the community.