factor. The case studies outlined below were selected to illustrate various implementation drivers.

5.1. Proactive conscience driven cleaner production: Cape Canaveral and Kennedy Space Center

The United Space Alliance (USA) operates facilities at the Kennedy Space Center and Cape Canaveral to refurbish the Space Shuttle's solid rocket boosters (SRBs) and prepare them for reuse (formerly operated by Pratt and Whitney). They have a corporate commitment to continuously reduce their three largest waste streams. Once these waste streams are reduced, other streams enter the top three and hence become the subjects of assessment.

To assist them in these continuous improvement efforts, the author was invited to assess three facilities associated with refurbishing the SRBs (see Fig. 1).

(1) In the Thrust Vector Control (TVC) clean room, component parts from the SRB engines and parachute cones are individually cleaned in a series of dip tanks. Cleaner production measures were identified to reduce rinsewater consumption and tank evaporation, and to recycle bath solutions. With the incorporation of Pratt and Whitney's facilities into those of USA, other waste streams have become more significant. However, when the TVC clean room measures are implemented, they are projected to reduce water consumption and waste generation in the TVC clean room by about two thirds.

(2) Biological growth in the refurbishment facility's cooling towers was controlled with an ozone generator and supplemented with chlorine addition. Cleaner production assessment found that cooling the ozone generator with chilled water could increase its effective output by about 30% (due to the solubility curve for ozone). This in turn could eliminate the need for supplemental chlorine. The resulting decrease in chloride accumulation would reduce the volume of blowdown necessary to manage the accumulation of dissolved solids in the cooling water.

(3) The SRB robotic hydrolasing facility uses high-pressure water (17,500 psi) to remove ablative coating from the surface of the SRB sections. The facility had set an objective to recycle 100% of this water. The author designed, pilot tested and helped commission a series of filtration, adsorption, ion exchange, neutralization, and ozonation facilities that are now recycling 100% of the water used in this process.

5.2. Regional bylaw driven cleaner production: Trimac Transportation

Trimac Transportation operates a facility in Oakville, Ontario, Canada, that cleans stainless steel semi-bulk paint containers (totes) and portable mix tanks for reuse by the automotive industry (see Fig. 2). The vessels are cleaned with water, chemicals and solvents. Specifically, a toxic solvent, methylene chloride (also known as dichloromethane), was being used to remove the adhesive left behind by numerous labels on the totes and for various touch-up work.

The facility was faced with multiple legislative drivers. The most pressing (deciding) driver was a recent amendment to the Region of Halton's sewer use bylaw. Among other things, the amendment added discharge limits for specific solvents (including 2 mg/L for methylene chloride).

Fig. 1. Proactive cleaner production at Cape Canaveral enables the United Space Alliance to recycle 100% of the water used to pressure clean the Space Shuttle's solid rocket boosters.