Environmentally Friendly Cutting Solutions

Nick Kapustka (EWI), Warren Peterson (EWI),
Dana Ellis (NCMS), Janice Keay (Penn State ARL), Ken Hoy (Dell Services)

EWI, Columbus, Ohio, USA, Email: nick_kapustka@ewi.org; Phone: 614-688-5175

The practice of dismantling and refurbishing naval vessels has historically relied on hot work processes (*e.g.*, oxyfuelgas cutting). Oxyfuelgas cutting (OFC) is currently the most commonly used method for large-scale metal cutting and preparation operations, *e.g.*, ship breaking. While this method is both cost-effective and efficient as a manual operation, it also creates large quantities of visible emissions. This has led to compliance issues with air pollution and clean water requirements. Failure to comply with the current or future regulations could lead to fines and/or project termination. This project sought to develop alternative environmentally friendly cutting methods and explore new methods of reducing emissions in order to comply with air operating and water discharge permit requirementsat Puget Sound Naval Shipyard Intermediate Maintenance Facility (PSNS IMF).Alternate oxyfuelgas cutting gasses and equipment were investigated as well as alternate cutting processes, such as plasma arc cutting and laser cutting. Practical requirements for ship breaking at PSNS IMF were also considered in these evaluations.

Specially designed equipment and procedures were developed for monitoring opacity during simulated demolition cutting of large plates. Submarine hull samples were obtained from PSNS IMF in both ½-in. and 2-in. thicknesses. Several plate surface conditions were evaluated, namely, clean, rusted, painted, and painted with Special Hull Treatment (SHT) tile. These plate samples were cut using a variety of cutting processes. Most of the work was focused on OFC. The opacity results from OFC trials on ½-in. plates were compared to similar measurements made using both plasma arc cutting (PAC) and laser cutting processes. Each process was evaluated using design of experiment (DOE) techniques. Separate DOEs were performed on the OFC, PAC, and laser cutting evaluations. Evaluation of the opacity data obtained in this program includedcorrections for the normality of the measured data, followed by regression curve fitting, and presentation of the curve fit data in “robustness plot” format. The predicted values from the regression equations from these DOEs were then compared in the analysis.

Overall, the primary finding was that opacity was strongly correlated to the amount of organic matter (*e.g.*, paint, SHT tile residue, rust) burned. Burning of thicker organic layers on the plate generated greater opacity. Further, the amount of organic material burned was integrally related to kerf width.Using the techniques and equipment studied, the laser based cutting process was found to produce the least opacity, followed by the OFC and PAC processes. However, judgments regarding safety, cutting speed, and kerf width considerations were used to recommend a modified version of OFC in the near-term for ship dismantling at PSNS IMF.If several technical and safety challenges could be overcome, laser cutting could offer very significant reductions in observed opacity. Procedures and consumables are provided for each process type that resulted in the lowest opacity levels in this investigation.