INTRODUCTION

Decommissioning of commercial nuclear power plants presents technological challenges. One major challenge is the removal of large components mainly consisting of the reactor vessel, steam generators and pressurizer. In order to remove and package these large components nozzles must be cut from the reactor vessel to precise tolerances. In some cases steam generators must be segmented for size and weight reduction.

One innovative technology that has been used successfully at several commercial nuclear plant decommissionings is diamond wire sawing.

DESCRIPTION OF THE ACTUAL WORK

Diamond wire sawing is performed by rotating a cable with diamond segments attached using a flywheel approximately 24 inches in diameter driven remotely by a hydraulic pump. Tension is provided using a gear rack drive which also takes up the slack in the wire. The wire is guided through the use of pulleys keeps the wire in a precise location.

Fig. 1. Nozzle cutting in progress.

Fig. 2. Fully segmented nozzle after diamond wire sawing is complete.

Table I below describes the physical and technical characteristics of the diamond wire saw system.

TABLE I. Technical Data.
Power Specification

Hydraulic Pump	50 HP Electric over Hydraulic
Power Supply	480v, 3 phase
Power Consumption	60 amps
Drive Wheel	24 inch with rubber insert
Hydraulic Motor	12.5 cubic inch displacement

ABOUT THE DIAMOND WIRE

The diamond wire consists of ¼ inch aircraft cable with diamond beads strung over the cable separated by springs and brass crimps. Standard wire contains 40 diamond beads per meter and can be made to any length.

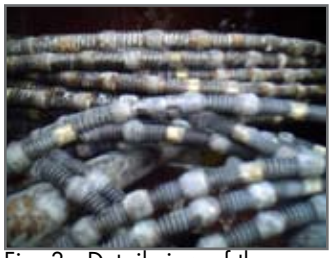

Fig. 3. Detail view of the wire.

Fig. 4. Detail view of the wire.

Fig. 5. Reactor nozzle setup.

COOLING THE DIAMOND WIRE

Cooling the wire and controlling the spread of contamination presents significant challenges. Under normal circumstances the wire is cooled and the cutting kerf cleaned by using water. In some cases of reactor nozzle cuts the use of water is prohibited because it cannot be controlled. This challenge was solved by using liquid Carbon Dioxide as the cooling agent. The liquid CO2 is passed through a special nozzle which atomizes the liquid into snowflakes which is introduced under pressure to the wire. The snowflakes attach to the wire keeping it cool and to the metal shavings. As the CO2 and metal shavings are released from the wire due to its fast rotation, the snowflakes evaporate leaving only the fine metal shavings as waste. Secondary waste produced is simply the small volume of fine metal shavings removed from the cut surface.

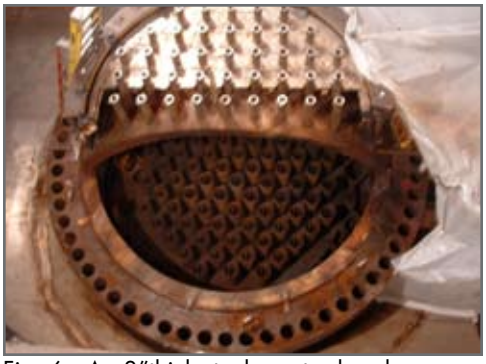

Fig. 6. An 8"thick steel reactor head segmentation by diamond wire saw.

Diamond wire sawing using CO2 cooling has been employed for cutting the reactor nozzles at San Onofre Unit 1 and at Connecticut Yankee. These carbon steel nozzles ranged up to 54 inch diameter with a 15 inch thick wall and an interior stainless cladding.

Fig. 7. CO2 cooling the wire while cutting copper.

Diamond wire sawing using traditional water cooling has been used to segment the reactor head at Rancho Seco and for cutting reactor nozzles and control rod drive tubes at Dairyland Power's Lacrosse BWR project.

ADVANTAGES

- ALARA. All cutting is preformed remotely significantly reducing dose. Stringing of wires is accomplished using long handle tools.
- Secondary waste is reduced to just the volume of material cut with the diamond wire.
- The potential for airborne contamination is eliminated.
- Due to the flexibility of the wire, any access restrictions and interferences can be accommodated using pulleys and long handle tools.
- The operation is quiet.

DISADVANTAGES

- With Liquid Carbon Dioxide cooling and cleaning, delivery of the material must be carefully planned. The longer the distance from the source to the cut area, the greater the chance for pressure drop and subsequent problems with line freezing.
- Proper shrouding and ventilation are required for environmental reasons.

RESULTS

In each case, the metal structures were cut at a precise location. Radiation dose was reduced significantly by operating the equipment from a remote location. The cuts were very smooth and completed on schedule. The following Figures show the cuts made at the various projects.

Fig. 8. Nozzle and safe end cuts made by diamond wire saw.

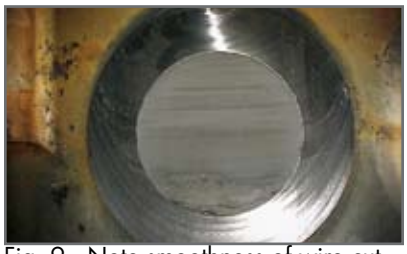

Fig. 9. Note smoothness of wire cut.

Fig. 10. Nozzle cut close to vessel surface to fit in canister.

COSTS

Each project must be analyzed individually and take into account many factors including access, radiological conditions, environmental conditions, schedule requirements, packaging requirements and size of cuts.

Fig. 11. Nozzle cut after completion. The nozzle measured 53" in diameter and had a 12" thick carbon wall with 1/2" thick stainless cladding.