# RADIOLOGICAL SURVEY OF PHASE 2 CONSTRUCTION SITE COMBUSTION ENGINEERING, INC. HEMATITE, MISSOURI

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## INTRODUCTION

The Combustion Engineering, Inc. facility in Hematite, Missouri, (CE) manufactures nuclear fuels under Nuclear Regulatory Commission (NRC) special nuclear materials license SNM-33. CE is in the process of constructing additional manufacturing and warehouse space and a new utility area to increase production capacity. This new construction is located between Buildings 240 and 255 (Figure 1). Construction of the new facility is to be completed in two phases. Phase 1 began in January of 1989 and extends from Building 255 to the utility area. Phase 2 construction, which began in June of this year, encloses the present utility over and connects the Phase 1 construction with Building 240. The utilities area includes the boiler room, maintenance office, recycle recovery vent room, and an asphalt driveway.

The potential for radiological contamination in the phase 2 area was considered to be low based on information describing the previous use history. The major surface area in Phase 2 consisted of a paved asphalt driveway. CE initiated a survey and soil sampling program prior to construction to determine if the area complied with the 30 pCi/g of total enriched uranium. The results of which indicated that soil concentrations exceeded the guideline level. Contamination in the Phase 2 area probably resulted from activities conducted in Building 240.

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CE's remediation efforts included excavating large quantities of contaminated soil which were packaged and shipped for offsite burial.

At the request of the NRC, the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Associated Universities (ORAU) conducted an independent radiological survey of the Phase 2 construction site on August 10, 1989. Procedures and results of that survey are presented in this report.

## SURVEY PROCEDURES

At the time of the survey, the walls and a roof of the new utilities facility had been erected. All of the footings and foundation for the building had been poured; excavated areas were still accessible.

1. A 10 m x 10 m reference grid system was established in the Phase 2 construction area; the grid origin was located in the southwest corner of the new structure. This grid is shown on Figure 2.

2. Beta-gamma and gamma scans were conducted over soil surfaces within the gridded portion of the construction site. Thin-window GM and NaI(Tl) gamma scintillation detectors with audible indicating scaler/ratemeters were used to perform scanning surveys. Locations of elevated radiation levels were identified and the licensee informed of the findings.

3. Surface soil samples were obtained at sixteen locations (Figure 2). Six of these samples were from locations of elevated direct radiation. Samples were analyzed by gamma spectrometry at the laboratory facility in Oak Ridge, Tennessee.

4. Exposure rate measurements were performed at the surface and 1 m above the surface at each of the sampling locations, using a gamma scintillation detector, cross calibrated for enriched uranium with a pressurized ionization chamber.

## RESULTS

A visual inspection of the Phase 2 construction site identified deep excavation adjacent to Building 240, extending 10 m from the building foundation (Figure 2). CE personnel stated that contaminated soil also extended underneath the building foundation. Surface gamma and beta-gamma scans confirmed CE's findings.

In addition, surface scans identified a small area with elevated direct radiation levels on a concrete footing adjacent to the boiler room. The approximate grid location was 13N, 14.5E. CE personnel were informed of the findings and removed the material. A follow-up scan indicated that removing this material significantly reduced direct radiation levels.

In the construction area, exposure rates measured at sampling locations ranged from 6 to 17 μR/h at both surface contact and at 1 m above the surface (Table 1). For comparison, the background exposure levels in the area of this facility were in the range of 6 to 10 μR/h; this range is typical of normal background radiation in this region of Missouri. Higher levels were near the western portion of the construction site and can be attributable to remaining contaminated soil under the foundation of Building 240.

Concentrations of uranium in soil are presented in Table 2. Levels of U-238 ranged from <2.8 to 48.5 pCi/g; U-235 levels ranged from <0.3 to 23.4 pCi/g. The highest concentrations of both uranium isotopes were observed in sample 4 from the grid coordinate 30N, 0E, having a U-235 concentration of 23.4 pCi/g and U-238 concentration of 48.5 pCi/g. An isotopic ratio of 26 for U-234 to U-235 activity was used to determine the total uranium concentration in these samples; this ratio was previously determined for Phase 1 construction activities. Based on this isotopic ratio, 10 of the 16 samples exceed the 30 pCi/g guideline for total uranium. Soil samples 5 and 11 have associated statistical uncertainty levels which make them borderline with respect to the guideline.

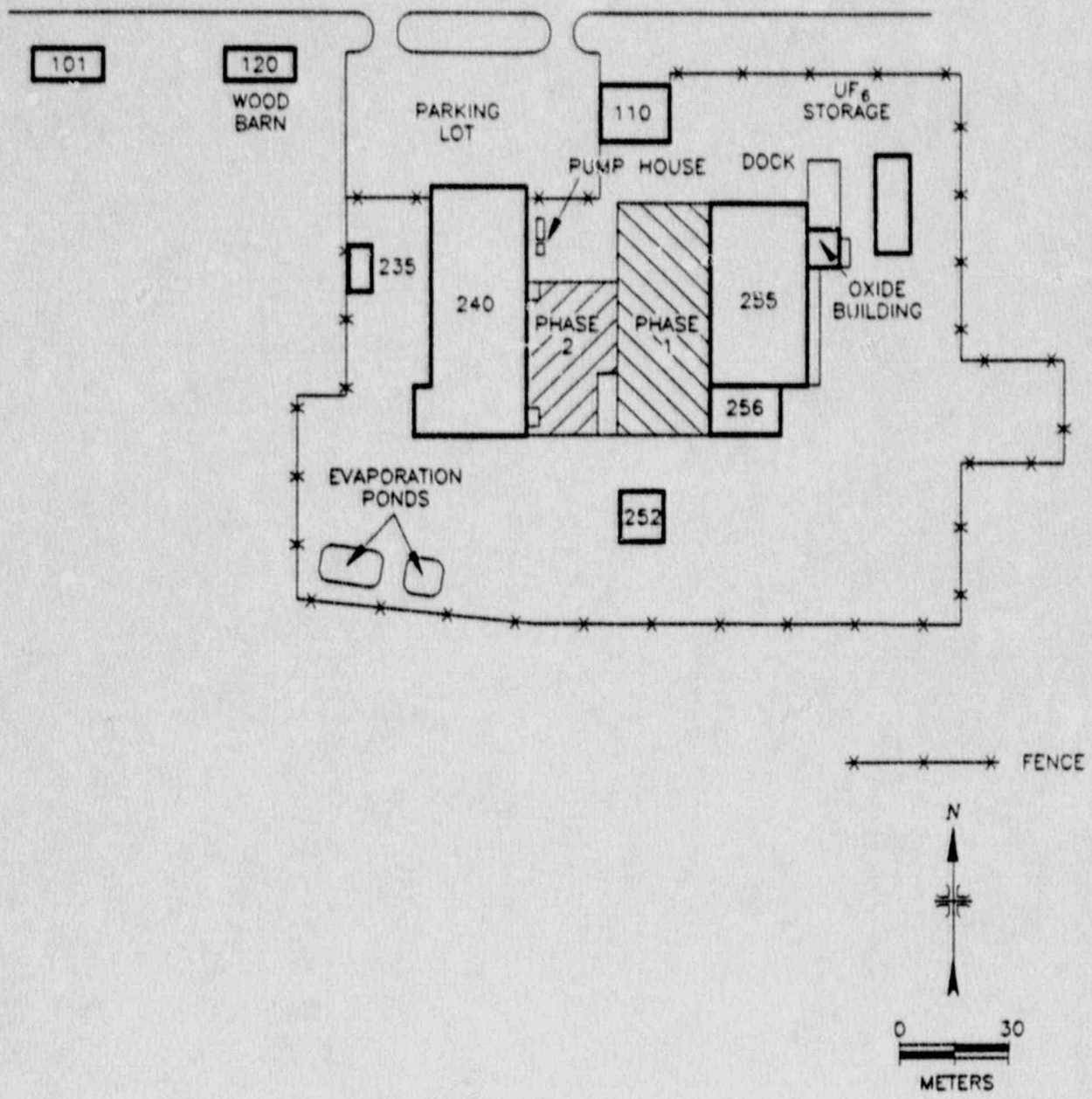


FIGURE 1: Layout of Plant Facility Indicating Phase 2 Construction Area

CEH4

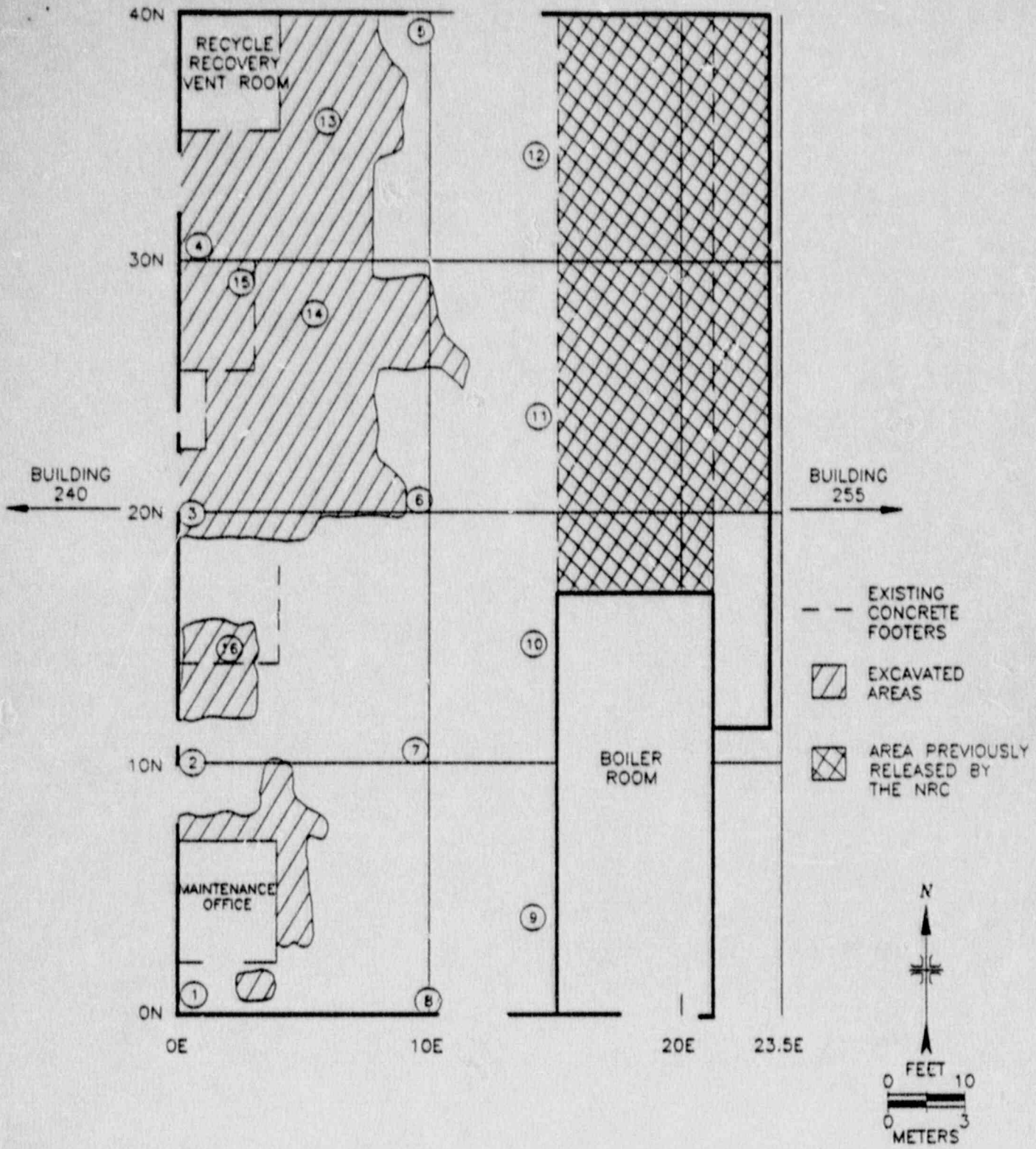


FIGURE 2: Soil Locations in Phase 2 Construction Area

TABLE 1

EXPOSURE RATE MEASUREMENTS
PHASE 2 CONSTRUCTION
COMBUSTION ENGINEERING, INC.
HEMATITIE, MISSOURI

| Location[a] | Grid Coordinate | | Exposure Rate (μR/h) | |
|---|---|---|---|---|
| | N | E | At 1 m Above Surface | At Surface Contact |
| 1 | 0 | 0 | 6 | 5 |
| 2 | 10 | 0 | 9 | 8 |
| 3 | 20 | 0 | 14 | 17 |
| 4 | 30 | 0 | 10 | 14 |
| 5 | 40 | 10 | 6 | 6 |
| 6 | 20 | 10 | 8 | 8 |
| 7 | 10 | 10 | 8 | 8 |
| 8 | 0 | 10 | 6 | 6 |
| 9 | 4 | 14 | 6 | 9 |
| 10 | 14.5 | 14 | 8 | 8 |
| 11 | 24.5 | 14 | 6 | 6 |
| 12 | 35 | 14 | 3 | 9 |
| 13 | 36 | 5.5 | 13 | 13 |
| 14 | 28 | 6 | 11 | 14 |
| 15 | 28.5 | 2.5 | 11 | 17 |
| 16 | 15 | 1.5 | 17 | 17 |

[a]Refer to Figure 2.

TABLE 2

URANIUM CONCENTRATIONS IN SOIL
PHASE 2 CONSTRUCTION
COMBUSTION ENGINEERING, INC.
HEMATITE, MISSOURI

| Sample[a] | Grid Coordinate N | Grid Coordinate E | Uranium Concentration (pCi/g) U-235 | U-238 | Total U[c] |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.2 ± 0.2[b] | 0.8 ± 0.5 | 6.2 |
| 2 | 10 | 0 | 0.3 ± 0.3 | 1.6 ± 0.5 | 9.7 |
| 3 | 20 | 0 | 3.9 ± 0.8 | 17.1 ± 2.5 | 122.4[d] |
| 4 | 30 | 0 | 23.4 ± 1.5 | 48.5 ± 1.6 | 680 [d] |
| 5 | 40 | 10 | 0.6 ± 0.3 | 1.7 ± 0.7 | 17.9 |
| 6 | 20 | 10 | 0.7 ± 0.3 | 2.7 ± 0.9 | 21.6[e] |
| 7 | 10 | 10 | 1.1 ± 0.4 | 6.3 ± 1.2 | 36.0[d] |
| 8 | 0 | 10 | <0.3 | 0.2 ± 0.3 | 8.3 |
| 9 | 4 | 14 | 1.7 ± 0.5 | 8.0 ± 1.7 | 53.9[d] |
| 9Duplicate | 4 | 14 | 1.3 ± 0.5 | 5.8 ± 1.1 | 40.9[d] |
| 10 | 14.5 | 14 | 3.2 ± 0.4 | 16.1 ± 0.1 | 102.5[d] |
| 11 | 24.5 | 14 | 0.8 ± 0.3 | 2.2 ± 0.8 | 23.8[e] |
| 12 | 35 | 14 | 2.4 ± 0.7 | 5.7 ± 1.8 | 70.5[d] |
| 13 | 36 | 5.5 | 4.5 ± 0.8 | 4.5 ± 1.8 | 126 [d] |
| 14 | 28 | 6 | 14.9 ± 1.2 | 21.1 ± 2.2 | 423.4[d] |
| 15 | 28.5 | 2.5 | 5.3 ± 1.0 | 13.3 ± 2.3 | 156.4[d] |
| 16 | 15 | 1.5 | 1.9 ± 0.6 | <2.8 | 54.1[d] |

[a]Refer to Figure 2.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.
[c]Calculated, utilizing U-234/U-235 activity ratio of 26.
[d]Exceeds guideline level.
[e]May exceed guideline level, based on statistical uncertainties in analytical data.