NMSS LICENSEE EVENT REPORT

License No. SUB-1452

Docket No. 040-08866

MLER-RI-89 -132

I. ACTION CONTROL DATA

Licensee Nuclear Metals, Inc.

Event Description damage to waste shipment

Event Date 5-25-89 *Report Date 8-1-89

II. REPORTING REQUIREMENT

[ ] 10 CFR 20.402 - theft or loss

[ ] 10 CFR 20.403(a)(b) overexposure/release

[X] 10 CFR 20.405 - 30 day report

[ ] Other ____

[ ] 10 CFR 35.33 Therapeutic Misadministration

[ ] 10 CFR 35.33 Diagnostic Misadministration

[ ]-License Condition

III. REGION I RESPONSE

[ ] Immediate Site Inspection Inspector____ Date____

[ ] Special Inspection Inspector____ Date____

[ ] Telephone Inquiry Inspector____ Date____

Licensee Representative and Title ____

[ ] PN [ ] Daily Report

[X] Information entered - Region I log and Outstanding Items List

[X] Review at next routine inspection

IV. REPORT EVALUATION

[X] Description of Event

[X] Levels of R/M involved

[X] Cause of Event

[X] Corrective Actions

[ ] Calculation Adequate

[ ] Letter to Licensee requesting additional information

Completed by: [signature] Date 9/19/89

Reviewed by: [signature] Date 10/21/89

V. SPECIAL INSTRUCTIONS OR COMMENTS

I x 30

* Reported by telephone to Region 1, May 1989.

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CF ADOCK 04008866
CDC

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NUCLEAR METALS, INC.

License No. SUB-1452
Docket No. 040-08866
MLER-RI - 89-132

1 August 1989

Mr. Virgil R. Autry
Bureau of Radiological Health
South Carolina Dept. of Health and Envir. Control
2600 Bull Street
Columbia, South Carolina 29201

Dear Mr. Autry,

We have completed our investigation of the incident involving our L.L.W. Shipment No. 0589-269. A copy of the report of investigation is enclosed and is also being forwarded to NRC Region II.

As anticipated in my letter of 15 June, corrective actions are still being evaluated and will be reported separately to you when complete. Major measures under consideration are summarized in the investigation report. We are encouraged that some of these actions will result in significant improvements to a process that we consider to be basically sound, and we are determined that NMI's response to this incident will reflect and reaffirm our long standing commitment to maintaining the highest levels of safety and regulatory compliance for our low-level waste management operations.

Sincerely,

Donald A. Barbour
Manager, Hazardous Waste

DAB:swf

Attachment

CF: Mr. Jimmy Still, Manager
Licensing, Chem-Nuclear Systems, Inc.

Mr. Robert Trojanowksi, State Liaison Officer
U.S. Nuclear Regulatory Commission, Region II

Mr. Frank Costello
U.S. Nuclear Regulatory Commission, Region I

DESIGNATED ORIGINAL
Certified By

1X30

Return Original to Region I

REPORT OF INVESTIGATION

1. Incident.

On Thursday, 25 May 1989, NMI L.L.W. Shipment No. 0589-269 was released to Ranger Transportation, Inc. for transport to the Chem-Nuclear Systems, Inc. Barnwell, SC disposal facility. The shipment consisted of 14 each 55 gallon drums containing cement encapsulated depleted uranium (D.U.) machine turnings and grinding sludges and seven each 7.1 cubic foot "F-54" steel boxes containing supercompacted D.U. machine turnings. The drums were loaded in the nose of the trailer four abreast (two in the rear row), and the "F-54" boxes were loaded in a single row at the rear. The truck arrived at the site Friday afternoon, 26 May. Since there was not sufficient time to unload the shipment before the close of business hours, the trailer was positioned in the holding area pending resumption of work after the three day Memorial Day holiday weekend.

Early Tuesday morning, 30 May, Chem-Nuclear personnel opened the trailer. They observed some smoke and noted discoloration of the yellow paint on the upper sides of three rear "F-54" boxes. The covers also exhibited some bowing. (See photo 1, attached.) The three rear boxes were removed from the trailer, set on the floor of the trench away from the section being filled, and covered with a pile of earth. The remainder of the waste packages were unloaded and staged nearby on the trench floor (with no earth cover).

Initial notifications included the DHEC resident inspector and Mr. Robert L. Toole of Carolina Metals, Inc., NMI's Barnwell, SC subsidiary. NMI was notified by Chem-Nuclear about 8:30 AM. I traveled to Barnwell and visited Chem-Nuclear the next morning, 31 May. After an initial discussion, including Dick Sappington and Ann Ragan of DHEC, we went out to the trench. One of the buried boxes was exhumed for examination. All visible surface paint was discolored or missing. The cover was displaced upwards approximately four inches from the top of the box due to expansion of the contents. (See photo 2, attached.) There was no visible smoke, indicating that the oxidation of the D.U. scrap had run its course, completely inerting the material. There was reason to suspect that the boxes were still (physically) hot, although no attempt was made to confirm this. The cover was removed from the box to facilitate observation. The visible contents of the exhumed box appeared to consist of the copper cans, largely in tact although somewhat expanded (accounting for the distortion or bulging of the box sides and displacement of its cover) and of a dark powdered uranium oxide. Since there was no evidence of melting (melting point of copper is 1083° C), it can be inferred that the reaction (oxidation) within the box did not reach this temperature. After completion of the inspection, the lid was replaced, and the exposed box was re-covered with soil. The drums and four unaffected boxes from the shipment were removed to the active section of the burial trench the following day. The three reacted boxes were held under their temporary soil cover for approximately six weeks to insure complete cooling. On 7 July, they were overpacked in metal LSA boxes, along with the potentially contaminated covering soil, and buried.

Photo 1: "F-54" box after initial removal fr'm trailer on 30 May 1989.

Photo 2: "F-54" box after exhumation on 31 May 1989.

2. Description of Waste Processing and Packaging.

DU Machine Turnings (SB). Turnings are collected in 55 gallon drums and five gallon pails containing water-based coolant emulsion at machining stations. Coolant emulsion is drained off for recycling immediately prior to transfer of collection drums to the waste processing area. Turnings are fed from collection drums into a ringmill pulverizer to break up the material into more uniform and tractable lengths. Milled turnings are sprayed with water on a vibrating screen to remove fine particles and are transported by conveyor through a hot solvent degreaser, where residual oils and coolant emulsion are removed by trifluoro-trichloroethane ("Freon" 113). The clean, dry turnings exiting the degreaser are batched in charges of approximately 2½ lbs. by an automated scale and travel by a conveyor to a 170 ton hydraulic briquetting press that compacts them into 4½ inch diameter cylindrical pucks about 3/4" thick, with a density of approximately 42% of solid uranium metal. Briquettes are loaded into 4½" diameter by 16" cylindrical copper cans. Circular copper lids are welded onto the filled cans, which now weigh about 50 lbs. Cans are then supercompacted on a 1250 ton up-acting hydraulic press, which increases the relative density to over 80% and reduces the overall length to about 8". The supercompacted billets (SB) are held 24 hours for observation to insure absence of reactivity, packed in special "F-54" steel boxes, sealed and shipped for controlled land burial. Each box contains about 54 billets and has a gross weight of approximately 3,000 lbs. Photographs of major equipment and stations in the briquetting and compacting line are attached as Appendix A. Since this processing technique was adopted in 1984, over 30,000 compacted D.U. scrap billets have been produced and shipped for controlled land burial without incident.

3. Probable Causes of the Incident.

Oxidation of uranium requires the presence of either atmospheric oxygen (air) or water. When it is supported by water, the oxygen from water molecules combines with uranium atoms, liberating hydrogen gas. Because of the high density of compacted uranium scrap, insufficient oxygen is available in entrained air to sustain combustion, and the compacted uranium scrap exhibits the same stability as a solid, massive piece of DU metal. This is due to the small interstitial or pore volume, the low density of air, and the fact that air is only 21% oxygen (by volume) at atmospheric pressure. On the other hand, if moisture were entrained in the same small void volume, about 3,500 times as much oxygen would be present. We conclude that the reaction observed involving Shipment No. 0589-269 resulted primarily from the briquetting of insufficiently dried turnings, which allowed the entrainment of moisture in one or more of the compacted scrap billets. Once the reaction got started, it was retarded by the lack of oxygen (which prevented a fire situation) but generated enough heat to propagate itself throughout the box and to adjacent boxes.

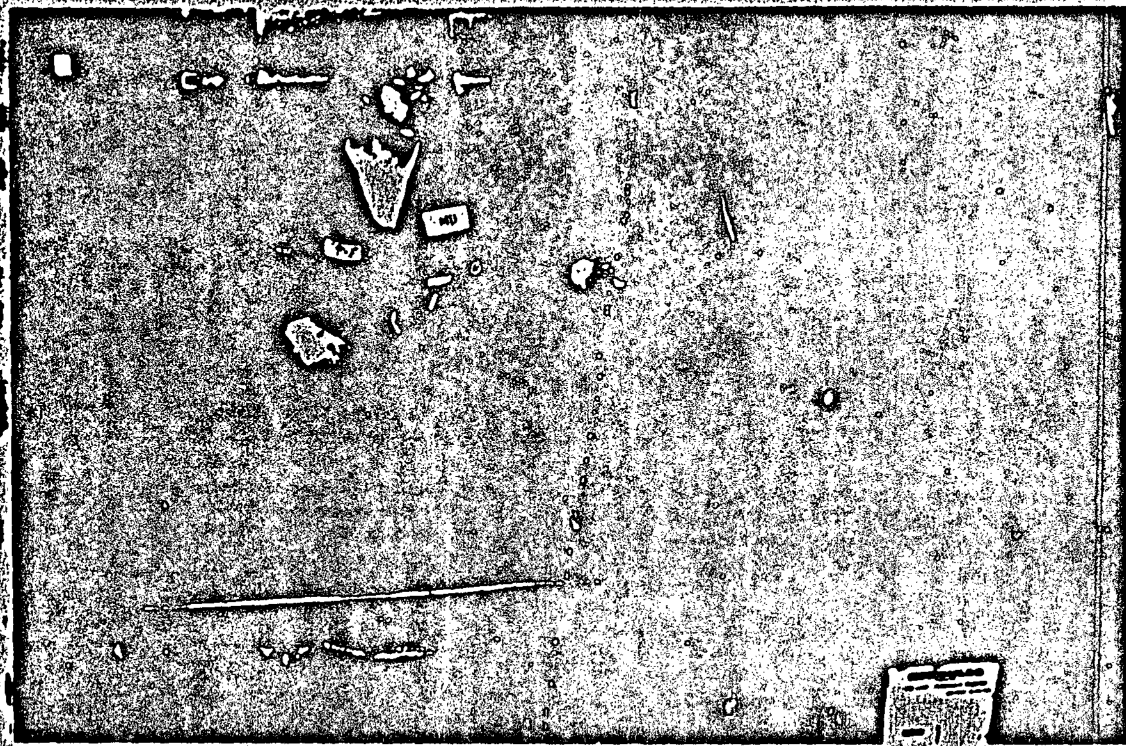
The pyrophoricity of uranium is also a direct function of the available surface area per unit mass of material (smaller particles are more pyrophoric). A contributing factor to the occurrence of this incident may have been related to a substantial change to NMI's manufacturing product mix, the previous month, when contracts for small caliber GAU-8 kinetic energy penetrators were completed. The resultant change to the proportion of types and the size distribution of D.U. machine chips delivered to the briquetting and compacting line may have caused an influx of smaller particles that were not adequately separated during the screening and degreasing steps or a higher percentage of brittle turnings that broke during the briquetting step, producing more fine particles within the briquette. Although such a situation is plausible, definite confirmation or quantification would be impractical.

The primary cause of this incident is concluded to be moisture entrained in the pore structure of the compacted scrap billets.

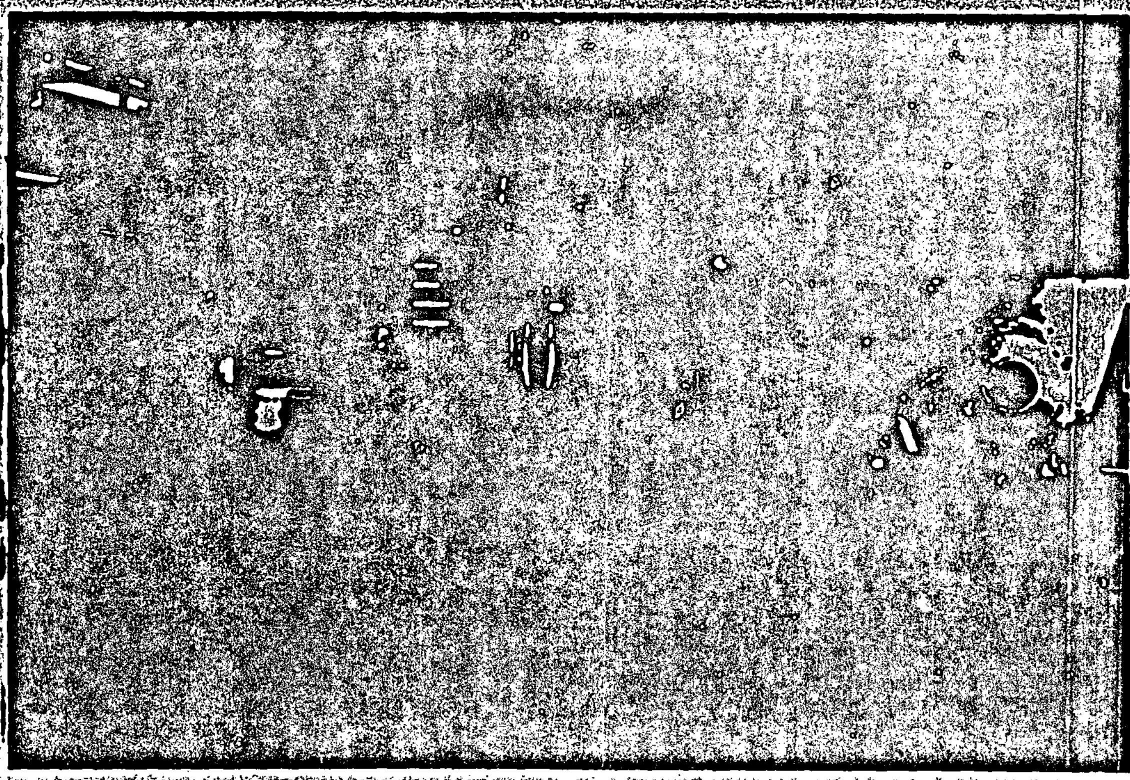
4. **Potential Corrective Actions.**

A number of potential corrective actions are being explored at this time. On 22 June the D.U. scrap briquetting and compacting line was reviewed by Dr. Wolfgang Pietsch of CompactConsult, Inc., and additional recommendations were obtained. Measures now under consideration include: use of wider grate openings in the ring mill and a larger sieve mesh in the vibrating sifter to increase chip size and improve separation of smaller particles (lower unit surface area), replacement of the solvent degreaser with a centrifugal chip wringer to insure drier feed to the briquetting press, use of sodium silicate and hydrated lime as a binder in briquettes to enhance stability by forming water insoluble bonds between chips and filling briquette pore spaces (thereby excluding water from entrainment), and improvements to quality control procedures (e.g. moisture control, monitoring of feedstock, and periodic formal process reviews). The systematic evaluation of these alternatives will involve new equipment testing (and possibly acquisition) and may require significant reconfiguration of the processing line. As a result, the adoption of final corrective actions is not expected to be completed for eight to ten weeks. They will be reported separately at that time.

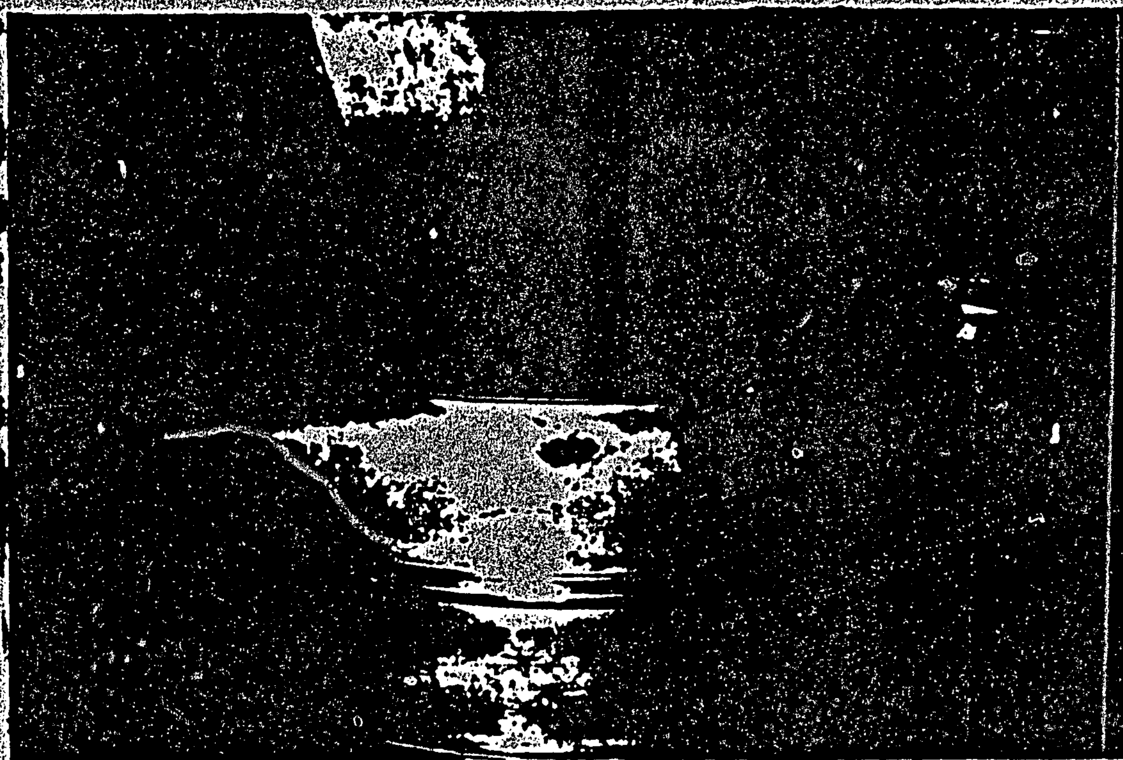
APPENDIX "A"
Briquetting and Compacting Process Sequence



1. Turnings are manually fed to ring mill conveyor.

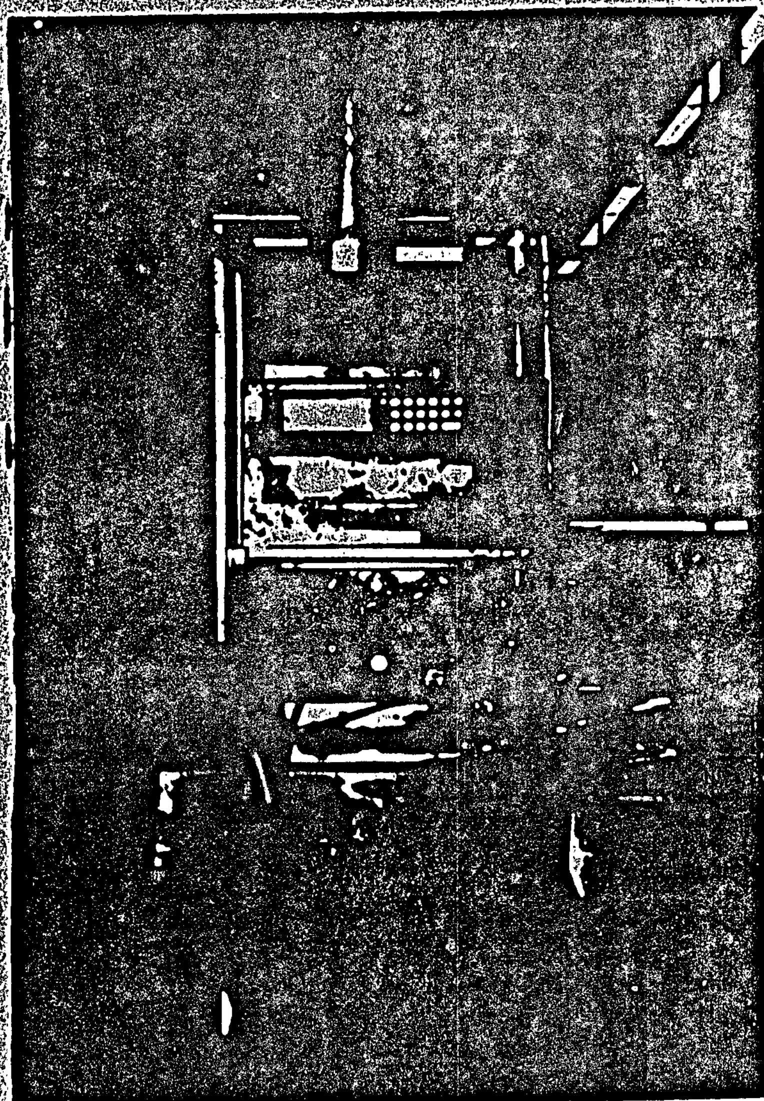


2. Ring mill with auxiliary spray system reduces long turnings to more uniform, tractable size.



3. Milled turnings and fines are separated on a vibrating screen. Turnings are discharged on to degreaser conveyor. (Fines are accumulated for cement encapsulation.)

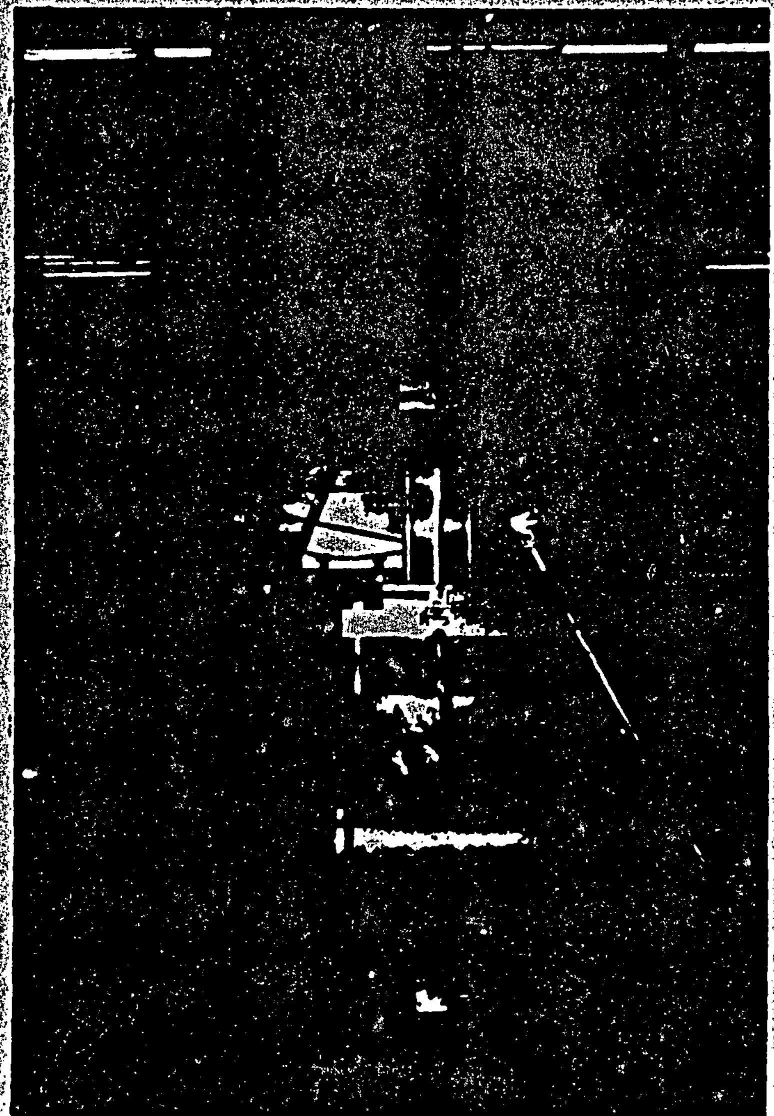
4. Degreaser removes residual oil, coolant, and water from turnings with hot trifluoro-trichloroethane solvent.



5. Cleaned turnings are collected on automatic trip scale; then batched charge of turnings is discharged onto briquetter conveyor.

6. 170 ton briquetting press produces a 4½" dia. by 3/4" thick "puck" out of turnings.

7. D.U. "pucks" are loaded in 4½" dia. by 16" long copper can; then top copper cover plate is welded on.



8. Canned briquettes are compacted on a 1250 ton hydraulic press to produce final scrap billet.

9. Fifty pounds of D.U. turnings at key processing points (left to right):
Raw machine turnings (in plastic bag)
Ring milled turnings (in 5 gal. pail)
Individual briquette (2½ lbs.)(w/16" copper can)
Compacted scrap billet