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METALLURGY AND HOT CELL BRANCH
EQUIPMENT CAPABILITIES MANUAL

MASTER

J. A. Hanny

IDAHO NUCLEAR CORPORATION
NATIONAL REACTOR TESTING STATION
IDAHO FALLS, IDAHO

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BY

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FOREWORD

This report presents the major equipment capabilities of the Metallurgy and Hot Cell Branch of Idaho Nuclear Corporation. The equipment listed herein is property of the U. S. Atomic Energy Commission and is located at Test Area North and Test Reactor Area at the NRTS, Idaho. The author wishes to acknowledge the following members of the Metallurgy and Hot Cell Branch who have contributed to the preparation of this report:

E. C. Adamson
D. R. Alvord
D. B. Hagmann
K. R. Hoopingarner
M. R. Martin

R. G. Mitchell
T. L. Murphy
C. G. Palmer
B. B. Tracy

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THE WORLD'S LARGEST HOT SHOP.

METALLURGY AND HOT CELL BRANCH EQUIPMENT CAPABILITIES

The multimillion dollar Hot Shop and supporting shop facilities at Test Area North (TAN) operated for the U.S. Atomic Energy Commission by Idaho Nuclear Corporation are the world's most versatile facilities for assembly, disassembly, maintenance, and examination of reactors and reactor components. The Hot Shop complex is supported by a fully equipped 50- x 160-ft Hot Cell Facility at the Test Reactor Area (TRA) which is divided into three (3) separate cells for flexibility in performing various types of metallurgical examinations and physical properties tests.

This document describes the available equipment used specifically for handling radioactive materials in the Hot Shop and supporting Hot Cells at TAN and TRA. The equipment in the supporting shop facilities at TAN, which include the warm shop and high bay area, is not included in this presentation.

The equipment described by this document is presented by six (6) general types of work:

- (1) Disassembly, repair, and reassembly of radioactive systems
- (2) Destructive disassembly of radioactive systems and specimen preparation
- (3) Specimen examinations
- (4) Physical properties testing
- (5) Radioactive material special handling and storage
- (6) Nondestructive testing.

Fig. 1 Test Area North (TAN) Hot Shop complex.

The equipment identified and described herein is presented by classification of service normally performed. The location of each piece of equipment is noted on each entry. Abbreviations used to specify location are listed as follows:

HS	= Hot Shop
RML	= Radioactive Materials Lab (adjacent to Hot Shop)
SES	= Special Equipment Service Room (adjacent to Hot Shop)
HCA	= Hot Cell Annex
HT LAB	= Heat Treat Lab
COLD LAB	= Nonirradiated Materials Testing Lab
TRA	= Test Reactor Area Hot Cells

Many of the smaller equipment items such as drills, tools, photography equipment, etc, are not described in detail. The hot cells each have a modest supply of small equipment for various remote handling operations, which are not listed in this document.

The facilities used for Metallurgical and Hot Cell operations are not covered herein but are described in a separate publication.

1. DISASSEMBLY, REPAIR, AND REASSEMBLY OF RADIOACTIVE SYSTEMS

The hot cells are equipped to handle nearly all disassembly, repair, and reassembly operations that can be accomplished with the human hand. The equipment primarily used to perform this type of work includes several types of manipulators, cranes, turntables, and various types of small tools such as impact tools, drills, holding fixtures, instrumentation equipment, etc. Figure 2 is a view of the remote handling equipment inside the main hot shop at Test Area North. Figure 3 shows the big hook on the 100-ton crane which services the hot shop. Figure 4, a view of a remote drilling operation using a magnetic attachment to hold a drill, is typical of the use of small tools in the hot cells. The hot cells are also equipped with many small supporting items such as portable monitoring, filtering and wall penetration equipment which are not listed in detail.

1.1 Manipulators

A large variety of manipulators are used in the hot cells to accomplish many different types of work. Descriptions and capabilities of each of the manipulators are presented in Table I. Limiting capabilities are described by the amount of weight the hands of fingers can handle. Figure 5 shows the Gradall Boom Manipulator which is especially adapted to reaching up under objects in the fully extended condition.

Fig. 2 Hot Shop equipment.

1.2 Cranes and Turntables

The hot cells have lifting capabilities up to 100 tons. The large 100-ton crane is shown in part by Figure 2 which illustrates the interior of the main Hot Shop. Table II presents the details of the cranes and turntables normally used in the hot cells and cold lab areas. Figure 6 shows the Hot Shop turntables with the PM-2A reactor vessel on the portable-elevating turntable.

Fig. 3 Lifting hook for 100-ton crane.

Fig. 4 Drill with magnetic attachment.

TABLE I
MANIPULATORS

<u>Type of Equipment</u>	<u>Manufacturer</u>	<u>Model</u>	<u>Range or Typical Use</u>	<u>Special Features or Attachments</u>	<u>Location</u>
Overhead Manipulator	General Electric		Can handle 500-pound load during all movements	Will service all of H. S. and SES room	H.S.
Bridge Mount Mechanical Manipulator	General Mills	300	65-pound maximum capacity in any position	750-pound maximum capacity of lifting hook. Will service all cells' interior areas	TRA
Bridge Mount Mechanical Manipulator	General Mills	500	100-pound maximum capacity in any position		RML
Bridge Mount Mechanical Manipulator	General Mills	100	40-pound capacity in any position		HCA
Bridge Mount Mechanical Manipulator	PAR	3000	140-pound maximum capacity in any position	Side-canting and separation extension. 4,000-pound chain hoist on bridge	RML
Wall Mechanical Manipulator	General Mills	300	65-pound capacity in any position	Dexterity in handling medium loads. Boom mounted	H.S.
Wall Mechanical Manipulator	PAR	3000	160-pound maximum capacity in any position	Boom mounted Side-canting and separation extension	H.S.
Wall Mechanical Manipulator	General Mills (Modified)	"C" Head	Remote handling used to work up under objects. 50-pound maximum capacity in any position (See Figure 3.)	Gradall boom and mount. Slim telescoping tubes allow reaching inside of objects	H.S.
Master Slave Manipulators	Central Research	"F"	50-pound capacity used for handling light operations in Hot Shop		H.S.
Master Slave Manipulators	Central Research	"E"	20-pound capacity used for handling delicate materials	X, Y, and Z extensions for additional reach	RML
Master Slave Manipulators	AMF & CRL	8	Light duty -- 20-pounds maximum capacity in any position	Side-canting and separation extension	HCA RML TRA
Wall Mechanical Manipulator	Ameray		Light duty -- for use in weighing boom mounted chamber		TRA

Fig.5 Gradall manipulator fully extended approximately fifty (50) feet above the Hot Shop floor.

TABLE II

CRANES AND TURNTABLES

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Crane, in cell	Chrisholm-Moore	Lodestar E	Capacity: 1000 pounds Used for moving and holding heavy experiments in hot cells	Bridge mounted; modified for remote operation in hot cells	HCA
Crane, Monorail	Robbins & Myers	F-3	Capacity: 5 tons. Used for moving storage and transfer casks behind hot cells	Monorail mounted; modified for remote operation	HCA
Hoist, tram	Chico	30	Capacity: 30 tons. Used for moving casks from outside of building into pool	Bridge mounted	Storage Pool
Crane, mobile	Vanguard Engineering	401	Capacity: 650 pounds (with boom fully extended). Used for moving casks and heavy equipment in cell area	Battery powered; mobile	HCA
Crane, manipulator	Wright		Capacity: 1/2 ton. Used to move master-slave manipulators into and out of cells	Bridge mounted	HCA
Crane, overhead	Whiting	7279	Hook No. 1 -- 100 ton capacity Hook No. 2 -- 10 ton capacity	Both hooks have 50 percent overload safety factor	H.S.
Crane, transfer	Yale Electric Winch	SC	Capacity -- 3 tons	Mounted on RML/HS door which moves out of RML on a track	RML
Crane, overhead	Shepard-Niles		Capacity -- 5 tons	Bridge mounted	Cold Lab
Crane, wall mount	Lodestar	"F"	Capacity -- 1/2 ton	Fixed on wall with 12 ft. swinging boom	Cold Lab
Crane, overhead	Robbins & Myers		Capacity: 15 tons Moving objects in the storage pool		Storage Pool
Crane, overhead	Wright		10-ton capacity		TRA
Hoist, in cell	(Not commercially available)		1-ton capacity	Positioning of Hoist is done outside of hot cell	TRA
Hoist	Yale		1-ton capacity	Hot Cell use	TRA
Jacklift, electric	Lewis-Shepard	E-4SL	Moving materials outside of Hot Cells		TRA
Portable elevating turn table	Baker Engineering		15-ton capacity -- 13-ft. diameter will raise from 5 ft. up to 18 ft. above the floor (see Figure 4)		H.S.
Floor turn tables			60-ton capacity -- 16-ft. diameter Rotates large fixtures and components		H.S.

Fig.6 Hot Shop turntables.

2. DESTRUCTIVE DISASSEMBLY OF RADIOACTIVE SYSTEMS AND SPECIMEN PREPARATION

One of the major applications of hot cell and cold lab equipment is for preparation of various types of specimens from reactor vessels, reactor components, or other irradiated and nonirradiated materials. Types of specimens prepared vary from custom-made specimens to standard ASTM specimens used in other metallurgical laboratories. The equipment used has been broken down into eight prime categories for further description.

2.1 Cutting

Cutting equipment is used for preparation of very small specimens as well as large specimens for Metallurgy and Hot Cell examinations. Some of the cutting equipment has been modified to accomplish delicate, precision work by remote control. The cutting equipment capabilities are presented in Table III. Figure 7 shows the rough cutting of approximately three inches of carbon steel with stainless steel cladding with an oxy/acetylene torch, being held by a wall-type mechanical manipulator. Figure 8 is a photograph of an abrasive sampling saw used frequently for quick, nonprecision cutting. Figure 9 shows a Marvel band saw cutting mechanical properties specimens from the PM-2A reactor vessel wall.

TABLE III
CUTTING EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Abrasive cut-off Machine	Buehler, Ltd.	10-1010AB	Suitable for specimens up to 3 in., cut length, and half-in. diameter		HCA Cold Lab
Abrasive cut-off Machine	Buehler, Ltd.	10-1030AB	Suitable for stock up to 15 ft. long and half-in. diameter		HCA
Ultrasonic cutter	(Not commercially available)		Used for ceramics, such as fuel pellets, etc; small items		HCA
Large abrasive cutter	DeWalt saw -- shop modified		Precision cutting and grinding. Modified for Hot Cell use	Table moves in X and Z motion Saw head moves in Y motion	RML
Pipe cutter	Rigid	300	Power driven. For cutting pipes up to 2 in. diameter size.		SES
Band saw	Wells	8M	Heavy duty cutting of metal objects		TRA
Automatic Hack-Saw	LiPe Rollaway Corp.	C	Used for cutting experiments pipe sections, etc. Suitable for specimens up to 4 in. across (in plane to be cut).	Adapted for Hot Cell use	HCA RML TRA
Automatic Hack-Saw	The Mine & Smelter Supply Company	C	Used for cutting experiments, pipe sections, etc. Suitable for specimens up to 4 in. across (in plane to be cut)	Adapted for remote use	Cold Lab
Skill saw	Dyna-flash	655	6-1/2-in. blade		H.S.
Portable band saw	Porter Cable	524	24 in. circumference (blade) 4 in.-high cutting space		H.S.
Power hack saw	Keller		18 in.-long blade 6 in. stroke		H.S.
Oxy/Acetylene Cutting torch	Victor		(See Figure 5)	Adapted for Hot Cells	H.S.
Sampling saw, abrasive	(Not commercially available)		For light, nonprecision cutting (see Figure 6)	Cutting head can be moved left or right and the specimen may be revolved under cutting wheel	RML
Saw, band	Rockwell	28-290	14 in. wood cutting; metal/wood cutting; plastic cutting		TRA
Saw, band	Manual	No. 8	Heavy duty cutting (see Figure 7) 18 in. long cut for single setting 12 in. high cutting space		SES
Hydraulic shear	(Not commercially available)		4-ton capacity on 10-in. Ram	Remote hydraulic actuation	TRA
Hydraulic shear	O'Neil-Irwin	No. 1	Can handle 16 gauge 6-in.-wide steel sheet		TRA
Abrasive cutter	(Not commercially available)		Nonprecision cutting	Air operated vise and power feed	TRA
Power hack saw	Rancine hydraulic and machinery	utility dry cut	Capacity: 6 x 6 in. for heavy cutting	Hydraulic operated vice with remote control	TRA
Sectioning machine	Hamco Machine		Light precision cutting with thin abrasive wheel	Dial indicator shows distance from previous cut	TRA
Sample punch	O'Neil-Irwin	1	Depth of throat -- 6-1/8 in. punches. 3/4 x 3/8 in. samples for metallography	Modified for remote use	TRA

2.2 Grinding

A variety of grinders are available to support cutting operations and preparation of various types of specimens. Many of these grinders have special features such as magnetic chucks, portable fixtures, and a special selection of grinding wheels to accommodate all types of grinding work. The grinding equipment is presented in Table IV.

2.3 Machining

Both mechanical and electric discharge types of equipment are available to machine specimens. Table V lists the machining equipment currently used.

Fig.7 Remote cutting of PM-2A reactor vessel with an oxy/acetylene torch.

Figure 10 shows a failed fuel element being machined by remote control, using a modified Bridgeport milling machine.

2.4 Etching, Cleaning, and Polishing

Equipment listed under this category are used for obtaining final finishes prior to specimen testing or examination. Etching, cleaning, and polishing equipment are presented in Table VI.

2.5 Specimen Mounting

Equipment under this category is limited to mounting metallurgical specimens in a suitable holding material to facilitate metallography examinations. Table VII lists the mounting equipment available.

2.6 Plating

Plating tanks and power sources are available to perform several types of plating of specimens and components. Plating is limited to nonirradiated materials. Plating equipment details are presented in Table VIII.

2.7 Heat Treating

Heat-treating furnaces are available ranging from small lab sizes up to approximately nine (9) cubic feet of interior space for heat-treating large specimens or components. Table IX lists the heat-treating equipment available.

Fig.8 Abrasive sampling saw.

2.8 Other Specimen Preparations

Items under this category include welders, environmental chamber, and fission gas samplers. Remote welding in the hot cells has been performed successfully without major problems. The equipment under this special category is described in Table X.

Fig. 9 Marvel band saw being operated by a manipulator.

TABLE IV

GRINDING EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Bench grinder	Black & Decker		10-in. grinder used for rough work on met. specimens		HCA
Bench grinder	Thor Power Tool Company	B6S-8139	6-in. grinder used for rough work on met. specimens		Cold Lab
Fine grinder	Buehler, Ltd.	39-1410AR	Fine grinding of met. specimens by hand; max. spec. size 4 x 4 in.		Cold Lab
Belt grinder	Buehler, Ltd.	16-1252AB	Initial surfacing of met. specimens; max. spec. size 4 x 6 in.		Cold Lab
Pneumatic grinder	Ingersoll-Rand	15120	Portable cutting; held in manipulator hand		RML
Hi-speed pneumatic Grinder	Wellows	G-125-A	Used for hi-speed cutting operations	Light-weight is held in master slave manipulator's hand	RML
Surface grinder	Do All	G-10	Will grind specimens up to a maximum size of 6 x 18 x 8 in.	Permanent magnetic chuck	SES
Bench grinder	Do All	D-3040	10 in. diameter wheels 1 HP motor		SES
Surface grinder	Brown & Sharpe	510	Grinding work 11 in. long, 5 in. wide, and 12 in. high to .0001 in. accuracy		TRA
Air grinder	Ingersoll-Rand	2560	600 rpm 4 to 6 in. blades		H.S.
Air grinder	Gast	16am-FRV2	7-1/2 hp 300 rpm		H.S.
Air grinder	ARPO	7025	5000 rpm		H.S.

TABLE V
MACHINING EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Lathe	Atlas Press Co.	NFC	6 in. Swing -- used for turning and cutting small samples	Set up for remote use	HCA
Electric discharge machine	Easco-Sparcatron		Will remove a minimum 1.5 cubic inches per hour (graphite electrodes)	SPF-25 Power supply 2 to 130 kcs in 5 graduated steps	RML
Lathe and mill	Maximat	Com	Combination lathe and milling machine. Used primarily for machine mechanical test specimens	Capable of remote control operation	RML
Lathe	Rockford	109H x 25	16 in. diameter max. size working piece	Tracing attachment	SES
Milling machine	Bridgeport	Universal	Cross travel 9 in.; vertical travel 16 in., longitudinal travel 24 in. (see Figure 8)		TRA SES
Lathe	Craftsman	101-27440	6-in. lathe, back geared		TRA
Lathe	Atlas Press	618	3-in. back geared lathe		T*RA

Fig. 10 Milling of a failed fuel element in hot cell.

TABLE VI

ETCHING, CLEANING, AND POLISHING

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Vapor blaster	(Not commercially available)		Cleaning and degreasing small parts up to 8 x 8 x 4 in.	Small grits most commonly used for delicate work	Cold Lab
Ultrasonic cleaner	Acoutica Association Inc.	DR-125AH	Cleaning small parts; 1/2 gallon cylindrical tank		HCA
Ultrasonic cleaner	Bendis Aviation Corp.	UG-2	Cleaning parts; tank size 9 x 14 x 12 in. deep		Cold Lab
Ultrasonic cleaner	Branson Ultrasonic Co.	AP-25	Cleaning parts; tank size 1/2 gallon cylindrical tank		HCA
Ultrasonic cleaner	Turco		Tank size 12 x 12 x 15 in.-stainless steel tank		RML
Ultrasonic cleaner	Buehler Ltd.	1950	Cleaning of metallurgical samples during polishing		TRA
Electropolisher	Buehler, Ltd.	1715-1AB	Etching and polishing met. spec. 10 amps dc, max. current 100 volts dc, max. voltage		HCA Cold Lab
Mircomet	Buehler, Ltd.	1740AB	Etching met. specimens, 1 amp dc, max. current 5 volts dc, max. voltage		HCA Cold Lab
Etcher and polisher	(Not commercially available)		Electrolytic etching and polishing		TRA
Vibratory polisher	Syntro Corp.	D-23529	Final polishing of met. spec.	Fitted with LPCOL control	Cold Lab
Vibratory polisher	Syntro Corp.	D-23529	Final polishing of met. spec.	Fitted with LPCOL control, adapted for Hot Cell use	HCA
Polishing attachment (Automet)	Buehler, Ltd.	1900AB	Polishing 5 met. specimens simultaneously and automatically		HCA Cold Lab
Polishing wheel and motor	Buehler, Ltd.	44-1503AB	8 in. wheels for lapping met. spec. low speed		HCA Cold Lab
Polishing wheel and motor	Buehler, Ltd.	46-1502AB	12 in. wheels for lapping met. specimens. High speed		HCA TRA
Polishing attachment (Whirlimet)	Buehler, Ltd.	60-1508AB	Polishing 3 met. specimens simultaneously and automatically		HCA Cold Lab TRA
Fine polisher (Vibromet)	Buehler, Ltd.	67-1510AB	Fine polishing of met. specimens up to 7 at a time		HCA Cold Lab
Etcher and polisher	(Non-commercially available)		Electrolytic etching and polishing		TRA
Polisher, Automet	Buehler Ltd.	60-1908	Final polishing of metallurgical samples		TRA
Polisher, (Vibromet)	Buehler Ltd.	67-1520	Final polishing of metallurgical samples		TRA
Polisher, Vibratory	Syntro	B-3B LPC-01	Final polishing of metallurgical samples	Remote controls; polisher is used in Hot Cell	TRA
Polishing table	Buehler Ltd.	1540-2	Hand polishing of non-radioactive materials		TRA
Polishing and examination apparatus	Buehler Ltd.		Complete portable equipment to spot polish and perform metallurgical examinations of large, in-place metal objects: pipes, pumps, vessels, etc	Spot size up to 2-in. area and 1/16 in. deep Examinations up to 450X	TRA

TABLE VII

SPECIMEN MOUNTING EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Mounting press	Buehler, Ltd.	20-1330AB	Mounting met. spec. for ease of handling; 1-1/2 x 1-1/4 in. mounts		Cold Lab
Mounting press	Precision Scientific Co.	11-1 Mod.	Mounting met. spec. for ease of handling; 1-1/2-in. mounts	Modified for remote use	HCA
Mounting press	(Not commercially available)		Remote mounting in bakelite of all types of specimens not exceeding 3/4 in. in width or height	Remote feed of identification washers. Variable heat and pressure	RML
Mounting press	Precision Scientific Co.	Precision Jarrett	1-1/4 in. diameter metallurgical sample mounts		TRA

TABLE VIII
PLATING EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Plating apparatus	Sel-Rex Corp.	315-50	Silver plating system; tank size 15 x 13 x 18 in. deep; max. output 6 volts dc, 50 amps dc; max. ambient temperature 105°F		Cold Lab
Plating equipment			Tanks (30 x 24 x 33 in.) for plating chrome, nickel, copper, zinc, cadmium, and anodizing aluminum	Caustic cleaning tank and power supply	Cold Lab
Power source (auxiliary)	P. R. Mallory Co.		Used in plating; max. out-put, 32 volts dc, 50 amps dc		Cold Lab
Rectifier unit	W. Green Electric Co., Inc.	MRIC4	Used in plating; max. out-put 48 volts dc, 100 amps dc; max. ambient temperature, 104°F		Cold Lab

TABLE IX
HEAT TREATING EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Furnace	Marshall Products Co.		Max. temperature, 2800°F; No. 1 6 x 18 in. interior size No. 2 3 x 24 in. interior size		HCA
Furnace	Lindberg Engineering Co.	B-2	Max. temperature, 2000°F; interior size, 4 in. h x 6 in. w x 3 1/4 in. diameter	Controlled atmosphere	HT Lab
Furnace	Lindberg Engineering Co.	RO-122410-A	Max. temperature, 2000°F; interior size, 13 in. w x 8 in. h x 3 1/4 in. diameter	Controlled atmosphere	HT Lab
Furnace	Lindberg Engineering Co.	152418 EL2	Max. temperature, 1250°F; interior size, 15 in. w x 19 in. h x 25 in. diameter	Controlled atmosphere	HT Lab
Salt furnace	Lindberg Engineering Co.	RO-1418	Max. temperature, 1650°F; interior size, 14 in. diameter x 24 in. deep		HT Lab
Furnace, tube	Hevi-duty Electric Co.	M-3024	Max. temperature, 1950°F; interior size, 12 in. long x 2-3/4 in. diameter		HT Lab
Furnace, tube	Hevi-duty Electric Co.	M-3012	Max. temperature, 1950°F; interior size, 12 in. long x 1 in. diameter		HCA
Furnace	Thermolene	F-A1620	Max. temperature, 2000°F; interior size, 5 in. w x 6 in. x 12 in.	Controlled atmosphere	TRA
Furnace	Despatch Oven Co.		Max. temperature, 1250°F; interior size, 37 in. w x 37 in. h x 32 in. diameter		HT Lab
Furnace	Harper Electric Furnace Co.	MM4618WC32	Max. temperature, 1650°F; interior size,	Controlled atmosphere	HT Lab

TABLE X

OTHER SPECIMEN PREPARATION EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Welder	Lincoln	400-400	60 to 400 amps AC-DC inert gas or metal arc	Adapted for remote use	RML
Welder	(Sureweld) National Cylinder Gas	GAMA 22A/C DC	5 to 300 amps AC-DC inert gas of metal arc	Adapted for remote use	RML
Welder	Linde	500	Up to 500 amps AC-DC inert gas or metal arc	Adapted for wire feed electrode	H.S. RML
Rotary welding positioner			Up to 6 in. diameter work piece	Variable speed adjustable from horizontal to verticle	RML
Environmental Chamber	Tenney	SIR-50-500	Temperature range -- 50 to 500°F size 3 x 3 x 7 ft.		Cold Lab
Fission gas Sampler	(Not commercially available)		Glass ware and vacuum system for recovery of fission gas from plate or tube materials.	Hydraulic punch attachment to puncture capsules	TRA
Fission gas samplers	(Not commercially available)		Drill/punch into capsule for fission gas collection. Primarily used to open 1-1/8 in. diameter samples	Sealed to prevent fission gas escape.	TRA RML

3. SPECIMEN EXAMINATIONS

Equipment under this section is grouped into three classifications for description. Photographic equipment is listed but not described since the photography in the Metallurgy and Hot Cell Branch is limited to hot cell requirements and not used specifically for general photography services.

3.1 Dimensional Measuring

Several types of instruments are available to determine specimen dimensions. Table XI lists these instruments.

TABLE XI

DIMENSIONAL MEASURING EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Micrometers	Assorted	Assorted	Accurate measurements up to 36 in.	ASTM calibration blocks available	RML TRA HCA Cold Lab
Vernier calipers general	Assorted	Assorted	Accurate measurements up to 26 in.	ASTM calibration blocks available	RML HCA Cold Lab
Optical gage	Bausch & Lomb Optical Co.	Dr-25B	Accurate measurements up to 4 in.	ASTM calibration blocks available	RML HCA Cold Lab TRA
Optical comparator	Jones & Lamson Machine Co.	BC-7 Mod.	Accurate measurements up to 6 in.	Modified for Hot Cell use	HCA
Boroscope	National Electric Instrument	24072	6 ft. -- with 90° viewing 1/4 in. tube		RML
Dial indicators	Scherr		Thickness measurements up to 6 in. with .0001 accuracy		TRA
Permascope	Twin City Testing	EC	Measures thickness of coatings		TRA

3.2 Metallographic Examinations

Equipment for metallography work is available for examination of both irradiated and nonirradiated specimens. The Reichert Teleatom metallograph provides very accurate determinations with magnifications up to 2500X. Table XII lists all metallograph equipment currently available. A portion of the Reichert Teleatom metallograph with the lead shield is shown in operation in Figure 11.

TABLE XII
METALLOGRAPHIC EXAMINATION EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Stereomicroscope	Bausch & Lomb Optical Co.	SKT-2	Magnifications: 10X & 20X. Used for low-power stereoscopic examination of metallurgical samples in "warm" lab.		HCA
Stereomicroscope	Bausch & Lomb Optical Co.	SKW-5	Magnifications: 5X to 45X. Used for low-power stereoscopic examination of metallurgical samples in cold lab.	Selection of illuminators	Cold Lab
Microscope	Bausch & Lomb Optical Co.	TBU-8	Magnifications: 25X to 500X. Used for microscopic examination of metallurgical samples in cold lab.	Modified for use with metallography mounts. Selection of illuminators	Cold Lab
Inverted microscope	Unitron Instrument Div., United Scientific Co.	McC3-1967	Magnifications: 25X to 1500X. Used for microscopic examination of metallurgical samples in cold lab.	Selection of filters, including polarized light. Adaptable to 35mm camera	Cold Lab
Metallograph	Bausch & Lomb Optical Co.	Balphot	Magnifications: 50X to 1000X. Used for detailed examination of metallurgical samples in cold labs.	Selection of filters, including polarized light; carbon arc or zirconium arc illuminators; black and white, color, or Polaroid photography -- 5 x 7 in.; viewing screen	Cold Lab TRA
Metallograph	Bausch & Lomb Optical Co.	Series XR280 Modified	Magnifications: 50X to 1000X. Used for detailed metallurgical examination of samples in Hot Cell.	Modified for use with highly radioactive materials. Selection of filters, including polarized light; xenon illuminator; black and white, color, or Polaroid photography -- 5 x 7 in.; viewing screen.	HCA
Macro-camera	Bausch & Lomb Optical Co.	L	Magnifications: variable to 20X. Used for low-power photography of metallurgical samples	Selection of illuminators; black and white, color, or Polaroid photography -- 5 x 7 in.	Cold Lab
Light Density Meter	Welsch Scientific Co.	Densichron	Used for measuring light density at film in metallography cameras		HCA
Metallograph	Reichert	Teleatom	Magnification 25X up to 2500X (See Figure 9)	Micro-hardness tester for Hot Cell use	TRA
Stereomicroscope	Lerma	2624	Stereo photos up to 30X magnification	Camera attachment, 4 x 5 in. press and 35mm stereo camera	TRA
Metallograph	Bausch & Lomb Optical Co.	Research	Magnifications: 50X to 1000X. Used for detail metallurgical examinations.	4 x 5 in. photographic equipment	TRA

3.3 Other Specimen Examinations

Equipment under this category include visual examination and gamma scanning equipment and is described in Table XIII. In addition to the equipment described, the Metallurgy and Hot Cell Branch also has a large selection of photography equipment and dark rooms to support visual and metallurgical examinations. Photography equipment available includes: Graflex cameras, stereo cameras, developers, printers, enlargers, dryers, negative illuminators, etc. All common film sizes can be used. Color film photography, is available when needed.

Fig. 11 Reichert metallography with shielded cover.

TABLE XIII

OTHER SPECIMEN EXAMINATION EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Scanning periscopes	Kollmorgen Corp.	No. 301	Magnifications: 2X and 10X, used for low-power examination of radioactive material inside Hot Cells	Fitted with camera base attachment for photographic work	HCA RML TRA
Stereoperiscope	Bausch & Lomb Optical Co.		Stereo viewing and photography to 30X	5 x 7 camera	RML
Stereo-viewing jig			Positioning specimens for examination and photography with the stereo-periscope	Variable speed X, Y, and Z positioning	RML
Stereo-viewer	Bausch & Lomb Optical Co.		Viewing of 3-dimension prints, negatives, and transparencies		RML
Periscope, wall	Lerma Engineering	2101	Magnification up to 20X	Camera attachment, 4 x 5 in. press	TRA
Gamma scanner	Radiation Counter	15	Used for scanning fuel plate and other radioactive materials associated with Hot Cell activities	Wall plug with probe and recorder to fit Hot Cell access holes	TRA

4. PHYSICAL PROPERTIES TESTING

The equipment described by this section has been grouped into five separate categories. Physical properties testing of irradiated and nonirradiated materials is one of the major functions of the Metallurgy and Hot Cell Branch. A complete group of physical testing equipment is available to perform a variety of tests and is described in detail under each of the following subsections.

4.1 Tensile and Compressive

A complete line of tensile and compressive testing equipment and accessories for elevated temperature and controlled atmosphere testing is listed in Table XIV. Two load frames (TT-C and TT-D) are available for the Instron Universal testing machine. Figure 12 shows a split tube furnace which has been opened and photographed at elevated temperature. Figure 13 illustrates the Tinius Olsen tensile and compressive testing machine in operation in the cold lab.

4.2 Creep, Fatigue, and Impact

The Universal testing machine described by Table XIV is also used for creep and fatigue testing. Table XV lists the equipment available for performing creep, fatigue, and impact tests on both irradiated and nonirradiated materials.

4.3 Hardness

A variety of hardness testing equipment is available for use in the hot cells and cold lab. The hardness testers used in the hot cells are especially adapted or modified for remote operations. Table XVI lists the hardness testing equipment available.

4.4 Weight and Density

Table XVII describes the equipment used for weight and density determinations. A high degree of accuracy is obtainable for weight and density determinations using either irradiated or nonirradiated materials.

TABLE XIV

TENSILE AND COMPRESSIVE TEST EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Universal testing machine	Instron	TT-C and TT-D	0-2 gm. to 0-20,000 lbs. tension 0-100 gm. to 0-20,000 lbs. compression crosshead speeds .002 to 20 in./min grip assemblies for threaded button head, tubular and flat specimens. Adapted to Hot Cell testing	Gage length control, extension cycling control, sample break detector, preset cycle counter, load cycling control, rapid return control, xcope reverse detector, marker control, strain gage pre-amplifier, decade crosshead speed control, extensometers and inert furnaces (see Figure 10)	HCA
Tensile and compressive test machines	Tinius-Olsen		0-600 lbs. to 0-60,000 lbs. Tension and Compression. Crosshead speeds .05 to 20 in./min Grip assemblies for threaded button head, tubular and flat specimens. Either irradiated or non-irradiated specimens can be tested (see Figure 11)	Extensometers and furnaces available	Cold Lab TRA
Split furnace	Hevi-Duty Electric Co.	70-S	Max. temperature: 1950°F Used for high temperature tensile testing	Adapted for use with tensile testing machines.	HCA
Split furnace	Marshall Products Co.	1800	Max. temperature: 800°F Used for high temperature tensile testing	Adapted for use with tensile testing machines.	HCA
Split furnace	Hevi-Duty Electric Co.	MK-3018	Max. temperature: 2200°F Used for high temperature tensile testing	Adapted for use with tensile testing machines.	HCA
Box furnace	(Not commercially available)		Max. temperature: 1000°F Used for high temperature tensile testing	Built for remote use with tensile testing machines.	HCA
Recorder-controller	Foxboro Co.	Module M/62	Used for furnace control	Adapted for use with above furnaces and testing machines	HCA
Recorder	Foxboro Co.	6420 DR-0	Used for furnace monitoring	Adapted for use with above furnaces and testing machines	HCA
Recorder	Minneapolis-Honeywell Reg. Co.	153X12U-X-30A1	Used for furnace monitoring	Adapted for use with above furnaces and testing machines	HCA
Thermocouples, assorted	Assorted		For use with above equipment; good up to 2500°F (approx.)	Designed for placement in furnaces by remote control	HCA

4.5 Other Physical Properties

Bend, burst, and resistivity are listed together under this category since only one piece of equipment is available for each type of test. These tests are not normally performed as often as other tests described under Section 5. The equipment available under this subsection is listed in Table XVIII.

Fig. 12 Split tube furnace and tensile testing machine.

Fig. 13 Tinius Olsen tensile testing machine in the cold lab.

TABLE XV

CREEP, FATIGUE, AND IMPACT TESTING EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Universal testing machine (see Table XIV)			Creep and fatigue testing		
Fatigue burst T _e testing machine	(Not commercially available)		Max. pressure 10,000 psi. Max. cycle rate 3-4 rpm. Used primarily for tests on irradiated in-pile tubes of various sizes	Automatic cycle and cycle counting	TRA
Impact tester	Baldwin-Lima-Hamilton Corp.	SI-1	Used for impact testing of standard sized specimens at various temperature. Max. impact 250 ft./lb		Cold Lab
Impact tester	Wiedemann Div., Warner-Swasey Co.	B.L.I. Mod.	Used for impact testing of sub-sized specimens at various temperature Max. impact: 16 ft./lb.	Modified for Hot Cells use	HCA
Impact tester	Tinius-Olsen		60 ft./lbs. maximum	Not adapted for remote work	TRA

TABLE XVI

HARDNESS TESTING EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Hardness tester	Wilson Mechanical Instruments Div., Amer. Chain & Cable Co., Inc.	4-JS	Used for making Rockwell "Superficial" hardness tests; designed with 12 in. of vertical gap		HCA
Hardness tester	Wilson Mechanical Instruments Div., Amer. Chain & Cable Co., Inc.	5-JR	Used for making standard hardness tests; designed with 16 in. of vertical gap		HCA Cold Lab
Hardness tester, Kentrall	Riehle Testing Machines	CT	Standard and superficial Rockwell Hardness testing	Can be used remotely	TRA
Microhardness tester	Wilson Mechanical Instruments Div., Amer. Chain & Cable Co., Inc.	FB Tukon Mod.	Used for taking Knoop and 136° Diamond Pyramid hardness tests; used for radioactive materials	Modified for Hot Cell use	HCA TRA
Microhardness tester	Wilson Mechanical Instruments Div., Amer. Chain & Cable Co., Inc.	FB Tukon	Used for taking Knoop and 136° Diamond Pyramid hardness tests; used in cold lab		Cold Lab

TABLE XVII

WEIGHT AND DENSITY EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Balance: Analytical	Mettler Instrument Corp.	B5-C1000 Mod.	Capacity: 1000 g. Precision: 0.0001 g Used for weighing and density determinations; for Hot Cell use	Factory modified to permit remote electrical operation. Modification B5 GD to permit weighing below weighing chamber	HCA
Balance: Pan	Mettler Instrument Corp.	K5	Capacity: 2000 g Precision: 0.0001 g Used for weighing primarily		Cold Lab
Balance: Analytical	Mettler Instrument Corp.	B6	Capacity: 100 g Precision: 0.02 mg Used for weighing and density determinations		Cold Lab
Balance: Analytical	Christian Becker	AB-2	Capacity: 200 g Precision: 0.02 mg Used for weighing primarily		Cold Lab
Balance: Beam	Ohaus Scale Corp.	3600 Triple Beam	Capacity: 2610 g Used for weighing and density determinations		HCA
Balance: Analytical	Wm. Ainsworth	SC	200 g capacity. Weights and density		TRA
Balance: Analytical	Mettler Instrument		160 g capacity. Weights and densities to accuracy of 0.0001 g	Pan assembly under the balance	TRA
Balance:	Stanton Instrument	A-42	General Hot Cell use. 300 g capacity 0.0001 g accuracy		TRA
Balance: Ohaus	E. H. Sargent		General Hot Cell use. 20 kg capacity 0.1 g accuracy		TRA
Balance: metrogram	H. A. Hadley	AE	General Hot Cell use. 1000 g capacity 0.01 g accuracy		TRA

TABLE XVIII

OTHER PHYSICAL PROPERTIES TESTING EQUIPMENT

<u>Type of Equipment</u>	<u>Manufacturer</u>	<u>Model</u>	<u>Range or Typical Use</u>	<u>Special Features or Attachments</u>	<u>Location</u>
Bend tester	Steel City Testing Machines, Inc.	GB-124	Hydraulic-type bend tester; max. load: 15,000 lb. on 15-sq.-in. ram. ASTM bend tests	Selection of rams with varying radii of curvature	Cold Lab
Burst testing apparatus	(Not commercially available)		Max. pressure 40,000 psi Used primarily for burst testing in-pile tubes or other tube specimens	Max. pressure indicating gage	TRA
Resistivity testing apparatus	(Not commercially available)		Used for electrical resistivity tests of irradiated materials		TRA

5. RADIOACTIVE MATERIAL, SPECIAL HANDLING AND STORAGE

This section describes the main pieces of equipment used to transport, store, and dispose of radioactive materials used in the hot cells. Table XIX lists and describes the special equipment available as defined above. The 48-x 70-ft storage pool for storing radioactive materials and components is illustrated in Figures 14 and 15. The storage pool will receive items to be stored directly from the plant roadway or via the Hot Shop and pool vestibule.

TABLE XIX
RADIOACTIVE MATERIAL, SPECIAL HANDLING EQUIPMENT

Type of Equipment	Manufacturer	Model	Range or Typical Use	Special Features or Attachments	Location
Shipping casks		100 series B.E. No. 44	3.75 in. diameter x 29 in. long chamber 20 in. diameter x 47.1 in. long overall	Gross weight -- 5,800 lbs.	H.S.
Shipping casks		200 series B.E. No. 790	4.22 in. diameter x 8 in. long chamber 16.75 in. diameter x 20.5 in. high overall	Gross weight -- 1,880 lbs.	H.S.
Shipping casks		300 series B.E. No. 46	7.5 in. diameter x 12.5 in. long chamber 20 in. diameter x 27.25 in. high overall	Gross weight -- 3,020 lbs.	H.S.
Shipping casks		350 series B.E. No. 895	7.75 in. diameter x 11.25 in. long chamber 26.25 in. diameter x 31.25 in. high overall	Gross weight -- 5,900 lbs.	H.S.
Shipping casks		500 series B.E. No. 791	4.25 in. diameter x 4 in. long chamber 17.5 in. diameter x 18 in. high overall	Gross weight -- 1,700 lbs.	H.S.
Shipping casks		700 series B.E. No. 596	7 in. diameter x 18.75 in. long chamber 14 in. diameter x 25.75 in. high overall	Gross weight -- 1,800 lbs. 300 curies -- max. limit	H.S.
Shipping casks		800 series B.E. No. 597	7.5 in. diameter x 42 in. long chamber 24 in. diameter x 54 in. long overall	Gross weight -- 9,600 lbs.	H.S.
Canning machine	CANCO	1	One quart size cans. Used to store specimens in racks in the pool		HCA
Glove box	Neilson Metal Industries		48 x 48 x 45 in. with 3/16 in. steel walls	Has ports for master slave manipulator use in Hot Cell	TRA RML HCA
Glove box			36 x 24 x 24 in. with 2 in. lead walls	Not used in Hot Cells	TRA
Charging carrier	(Not commercially available)	No. 1	Will handle objects not exceeding 5-1/2 in. diameter x 27 in. long	Shovel moves load into cell	TRA
Charging carrier	(Not commercially available)	No. 2	Will handle objects not exceeding 5-1/2 in. diameter x 60 in. long	Shovel moves load into cell	TRA
Charging carrier	(Not commercially available)	No. 3	Will handle objects not exceeding 7 in. diameter x 60 in. long	Shovel moves load into cell	TRA
Storage cask	(Not commercially available)		Will store objects not exceeding 3-1/2 in. diameter x 12 in. long	Dry objects only	TRA
Disposal carrier	(Not commercially available)		Will handle objects not exceeding 12 in. diameter x 28 in. long	Inner container opens from bottom of carrier to discharge load for site burial	TRA H.S.

Fig. 14 Storage pool (48 x 70 ft.).

Fig. 15 Storage pool (elevation).

6. NONDESTRUCTIVE TESTING

The operation of the hot cells necessitates maintaining a minimum amount of nondestructive testing equipment to perform inspections as required by various sponsors. The equipment available for nondestructive testing is presented in Table XX.

TABLE XX

NONDESTRUCTIVE TESTING EQUIPMENT

<u>Type of Equipment</u>	<u>Manufacturer</u>	<u>Model</u>	<u>Range or Typical Use</u>	<u>Special Features or Attachments</u>	<u>Location</u>
Thickness tester	Branson Instruments, Inc.	Vidigage	Accuracy 0.1 percent. Used to measure film and plate thickness, etc.		Cold Lab
Reflectoscope	Sperry Products Inc.	UR	Used for ultrasonic detection of flaws, etc.		Cold Lab
Cobalt source	Budd Instrument		10.5 curie source	Mobile cask	Cold Lab H.S.
X-ray machine	General Electric	Resotron 300	300 ku max. potential 10 ma max. current	Mobile unit	Cold Lab
Portable dye-penetrant tester	Magna Flux Corp.	SK-3	Aerosol can type		Cold Lab
Dye-penetrant tester	(Not commercially available)		4 tanks -- 4 x 4 x 3 ft. deep 1 drying over -- 4 x 4 x 4 ft.		Cold Lab
Magnetic particle testing machine	Magna Flux Corp.	ARQ-466	Max. dc current: 2400 amps continuous, 500 amps intermittent Used for met particle testing. 25 in. diameter loop, 6 ft. bed		Cold Lab
Magnetic particle testing machine	Magna Flux Corp.	KCH-3D	Max. ac current: 600 amps continuous, 3000 amps intermittent. Max. dc current: 1250 amps continuous, 3000 amps intermittent. Used for dry particle testing		Cold Lab
Demagnetizer	Magna Flux Corp.	SB-911	440 volts, 25 amps, 9 in. coil		Cold Lab