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# Molten Metal Technology 1989-1995 (A)

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***"A shining example of American ingenuity, hard work and business know-how"***
Al Gore
Vice President, United States

***"It can literally revolutionize our ability to deal with toxic wastes"***
Maurice Strong
Secretary General, 1992 United Nations Earth Summit

Just six years after its founding in 1989, Molten Metal Technology Inc. (MMT) was on the verge of huge successes. The company had successfully developed an exciting new technology, *catalytic extraction processing* (CEP) that would not only break down hazardous and radioactive wastes into benign forms but also recycle them back into marketable products. Buoyed by the enthusiasm of Wall Street analysts, Washington insiders, environmentalists, and the scientific community, the company had just enjoyed a year of stock growth from just under $20 to almost $40 per share (see Exhibit 1) based on revenue growth of more than $44 million. (See Exhibit 2) *Industry Week* heralded CEP as the "technology of the year," having the promise "to solve a wide range of hazardous and toxic waste problems in an economically feasible way."[1] *Environmental Science & Technology* featured the technology in an 11-page in-depth scientific analysis.[2] *Pollution Engineering* magazine anticipated that CEP would "revolutionize" radioactive waste disposal.[3] Even the business magazine *The Economist*, featured the technology in an article entitled "Waste Management: Hot Solution."[4] The company's meteoric success was largely attributed to the dynamic leadership of Bill Haney and Chris Nagel and their ability to draw upon strategic global corporate partnerships, federal contracts, regulatory opportunities, and the burgeoning environmental awareness shaping U.S. society.

*This case was prepared by Andrew Hoffman, Professor of Organizational Behavior, Julie Smith, MBA Student, and Steve Soukup, MBA Student, of Boston University as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.* 

Excitement about MMT's experimental process continued to grow for several years. Although the process passed laboratory tests, commercial implementation still lay ahead. The company had carefully orchestrated its commercial demonstration programs to learn from and share with a cross section of industry and government entities. By the end of 1995, Molten Metal was on schedule to make the transition into full commercialization. Bolstered by external praise, strengthened by high-profile strategic alliances, and armed with an enthusiastic and highly qualified staff, MMT embarked upon the new year. At this critical moment for the company, Haney and Nagel contemplated the company's short- and long-term future and tried to predict the hidden risks and pitfalls that lay ahead. What were the next crucial moves that they should consider to assure the continued success of Molten Metal Technology as it attempted to transition into commercial development?

## A Dynamic Duo

MMT was the brainchild of Christopher Nagel and William Haney, two young men with differing backgrounds, joined by the entrepreneurial academic community of Cambridge, Massachusetts. In 1987, Chris Nagel first approached John Preston, Director of Technology Development at the Massachusetts Institute of Technology (MIT), where Nagel was a young graduate student. Preston, charged with marketing the many inventions developed by the faculty and students of MIT, listened with interest as Nagel described a method he had devised to dispose of hazardous wastes[5] by dissolving them in a bath of molten metal. Nagel, in fact, had already patented the process, which he eventually labeled catalytic extraction processing (CEP*)*, while working as a manager of energy conservation and coordination at the former U.S. Steel Corporation (now USX).[6] Nagel's career at USX began in 1982, directly after graduating from Michigan Technological University with a bachelor of science in chemical engineering. "My office," he recalled, "was sandwiched in between the blast furnace and the Q-BOP. . .torpedo cars on rails would pass by carrying hundreds of tons of hot metal."[7] This daily routine planted the seeds that eventually led Nagel to develop CEP. He would ultimately earn his Ph.D. from MIT in chemical engineering, writing his dissertation on the "Identification of Hazards in Chemical Process Systems."[8] Nagel's dilemma in 1987 however was what to do with his patented technology. Despite his desire to commercialize the concept, he had no business experience.

Preston's interest was piqued. He realized that "the concept was a potential blockbuster," but it was not until much later that a clear opportunity to advance Nagel's dream of commercialization presented itself.[9] That opportunity came in the form of William M. Haney, III, who, at the young age of 27, was already a self-made multimillionaire. Haney had recently sold FuelTech, a company he had started with a classmate while a freshman at Harvard. FuelTech was based on a fuel-saving process licensed from the inventor. Haney used his Harvard connections to raise millions of dollars in venture capital for FuelTech and before long was balancing his class schedule with his job running a multimillion-dollar company.[10] The sale of FuelTech yielded $200 million, $15 million of which went to Haney. He was looking for something to do with it when he was approached by Preston in 1988. Haney was immediately impressed with Nagel's ideas about CEP and was fascinated by its ability to not just treat hazardous wastes but also recycle them into usable products. As Haney later reflected, "the opportunity that this technology promised—to shift the paradigm entirely—was really what grabbed me."[11] Preston played matchmaker to Nagel and Haney, and Molten Metal Technology was born.

Nagel and Haney were different, but their strengths and styles seemed to fit well together. Nagel grew up in Royal Oak, Michigan, a suburb of Detroit. His interest in chemistry dated back to grade school. Nagel recalled an incident from the 7$^{th}$ grade in which he nearly blew himself up after dropping a small piece of sodium into water.[12] Haney on the other hand, grew up in Portsmouth, Rhode Island, and showed early signs of the entrepreneurial spirit that would later drive him as he delivered newspapers, sold greeting cards door-to-door, painted houses, and even erected circus tents.[13] Dividing responsibilities within the newborn company, Nagel became Director and Executive Vice-President of Science and Technology — or simply, "chief scientist." Haney assumed the role of President and CEO. At the same time that he founded MMT with Nagel, Haney also started Energy BioSystems Corporation to develop a system used to desulfurize fuels and petrochemicals.[14]

Each seemed to revel in his role. Haney, the consummate networker and promoter smiled in his chinos and denim shirt, pointing out that "people still ask me if this new technology for recycling hazardous waste is too good to be true. In 1950, if I had told you that on a piece of silica the size of your thumbnail someone would produce something that would have the thinking capacity of 400,000 people for 400,000 days, what would you have said? Yet we now accept that as perfectly normal. I would argue that this took a much larger leap of technological fancy than what we are doing at Molten Metals."[15] A letter from Vice President Al Gore hangs proudly in Haney's office, bearing the inscription "[To] my great friend."[16] While Haney rallied support, Nagel, described as "thin, intense, and bookish," worked "long hours with his staff of engineers and chemists dreaming up new applications and pouring over data from the company's test plant." It was said that "he seemed relieved not to be bothered with daily business tasks and happily gave Haney most of the credit."[17]

## Catalytic Extraction Processing (CEP)

John Preston brought Haney and Nagel together, but it was CEP that was the glue of MMT. At MMT's Recycling, Research and Development Facility in Fall River, Massachusetts, the company demonstrated how CEP converted waste material into useful materials by injecting it into a 3,000ºF molten metal bath. (See Exhibit 3) The catalytic properties of the metal destroyed the molecular bonds of the waste, reducing it to its constituent elements. The elements were then recombined to make gases, specialty inorganics, or metals that could be productively used in other industrial activities. MMT boasted that CEP could completely eliminate all hazardous compounds, thus exceeding regulatory emission and residual standards. The innovation created a closed-loop process with air emissions one-fifth to one-fiftieth the volume of an incinerator.[18] A second new process, Quantum-CEP (Q-CEP), expanded the CEP concept to use a molten metal bath to separate radioactive and nonradioactive elements to reduce the volume of radioactive waste before being sealed for final disposal.

MMT claimed that CEP could take a "100,000-ton-per-year waste stream and turn it into less than 5,000 tons of waste with the remainder transformed into useful products."[19] The market value of the recycled products and the compact size of the CEP were among the advantages that MMT used to promote the process as one that could virtually pay for itself. "The metal is about ten times more efficient, so our units can be about ten times smaller than an incinerator with comparable capacity," noted Dr. Ian Yates, director of marketing. "This will make our capital costs one-half and our operating costs one-third that of an incinerator of the same size."[20]

## The Hazardous Waste Market

### *Regulation-Driven*

The market for hazardous waste services originated with two federal laws: the Resource Conservation and Recovery Act (RCRA)[21] and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), or Superfund.[22] RCRA was passed in 1976 and regulated the transportation, treatment, and disposal of newly created hazardous waste. Prior to RCRA, there were few standards for hazardous waste disposal. It was either buried in dumps and landfills with nonhazardous waste or illegally disposed of by "midnight dumpers." RCRA established a "cradle-to-grave" program by which those who manufactured hazardous wastes were held responsible for them until they were securely disposed of.

Superfund was passed in 1980 and required that companies clean up abandoned hazardous waste sites. The key event that precipitated its enactment occurred at Love Canal, New York, in 1978 when it was revealed that 21,800 tons of toxic chemicals lay beneath the homes of almost 800 residents of a suburb of

Niagara Falls. The chemicals had been buried there between 1942 and 1953 by Occidental Chemical Corporation and its predecessor, Hooker Chemical Company. In 1978, President Carter declared the area the nation's first federal emergency for a nonnatural disaster, authorizing the purchase of homes by the government—more than 25% of which were destroyed.[23] Just over two years later, President Carter signed the Superfund into law. As part of its mandate, companies would be held liable for the cleanup of any waste sites for which they had a part in creating over their entire history. No matter how minor the involvement, a company could be retroactively penalized for actions that were legal when executed.

In sum, businesses were faced with the dual liability of identifying what part of their existing waste was classified as hazardous and to what extent their past waste stream exposed them to the expensive task of waste site cleanup. In both cases, the universe of regulated wastes and waste sites grew steadily. Under RCRA, there were initially only 15,000 companies that generated more than the 2,200-pounds-of-waste-per-month threshold that required oversight. However, when RCRA was reauthorized and amended in 1984, the threshold was reduced to 220 pounds per month, increasing the number of affected generators to 175,000. The 1984 amendments also increased the number of regulated substances to over 400. By 1991, that number had doubled to 800.[24] The burden of determining whether newly created substances were hazardous was the responsibility of the generator, who was responsible for completing and submitting forms to the Environmental Protection Agency (EPA) detailing every step of the waste's life from creation to disposal. Further, any company that stored, treated, or disposed of a hazardous waste was required to obtain a RCRA "Part-B" permit—an expensive and complicated process.

When Superfund was enacted, it was believed that there were between 1,200 and 2,000 sites that could potentially cause serious problems to human health, requiring a total cleanup cost estimate of between $3.6 million and $44 million.[25] By 1990, however, the number of sites listed on the EPA's National Priority List (NPL) had reached 1,246 (those sites considered so severely polluted that immediate action was necessary). Twenty-six thousand sites of lesser severity were also listed on the EPA's Hazard Ranking System.[26] The General Accounting Office estimated that the list could grow to 368,000 sites if a more comprehensive inventory was taken.[27] By 1992, the estimated cost to clean up this universe of sites reached as high as $750 billion.[28]

While Superfund and RCRA requirements prompted industrial markets to clean up hazardous wastes, they also precipitated attention in certain government agencies to deal with their present and past waste streams. In particular, spending at the Department of Energy (DOE) and Department of Defense (DOD) grew significantly in the early 1990s as these agencies began to remove hazardous and nuclear waste from historic nuclear and weapons manufacturing facilities. In June 1990, DOE published its *Environmental Restoration and Waste Management Five-Year Plan* for fiscal years 1992 through 1996. The plan identified 3,700 potential release sites at 500 facilities, with an additional 5,000 "vicinity properties," which could also be affected by their proximity to DOE facilities (in addition to the 17 DOE facilities already on EPA's NPL list). DOE spending to clean these sites was expected to grow from $4.4 billion in 1991 to $6.3 billion in 1995, with the total to reach more than $30 billion.[29] DOE also shifted considerable spending to the detoxification and disposal of low-level nuclear wastes (such as uranium hexaflouride) produced at nuclear power plants operating throughout the country.

DOD was developing a similar set of programs to clean present and past waste streams. In 1984, the Defense Environmental Restoration Program was established to clean up an estimated 14,400 sites at 1,579 active installations and 7,100 formerly used properties (there were 96 DOD sites on the EPA NPL list). DOD spent $600 million on cleanups in 1990 and $1.1 billion in 1991. Total DOD spending was expected to reach over $14 billion.[30]

***An Industry Emerges***

The initiatives spurred by RCRA, Superfund, and government cleanup operations created unprecedented opportunities for the waste management industry. The new industry focused on the many aspects of the waste cleanup and disposal market, including:

- *analytical chemistry services* to determine the composition of a waste in order to assure safe treatment and disposal;
- *consulting services*, including site assessments, risk assessments, and engineering plans for site remediation and source-reduction plans;
- *engineering and construction services* to build large-scale pollution control equipment (e.g., test wells, incinerators);
- *transportation services* to transport hazardous wastes;
- *emergency response* to provide rapid response and spill containment in the event of an accident; and
- *treatment and disposal services* to alter the physical, chemical, or biological character of a waste to make it less of an environmental threat before disposal or storage.

Several large companies, including Chemical Waste Management (CWM), a subsidiary of Waste Management Inc. (WMI), and Rollins Environmental Services expanded under RCRA and Superfund to become full-service hazardous waste management firms. For example, in 1980, CWM (then WMI), the industry leader, derived 12.9% of its $656 million in revenues from hazardous wastes. By 1990, 90.6% of its $1.1 billion in revenues came from hazardous wastes.[31] The market was highly fragmented with thousands of smaller firms emerging as specialists in specific services and/or geographic regions. For new entrants, the market was highly competitive with many small firms seeking subcontractor relationships with larger contracting companies. The larger, established firms dominated the business, and smaller firms were forced to rely on these heavyweights for entry into the larger markets.

The majority of the industry's revenue was derived from waste disposal, the aspect of the market on which MMT had set its sights. In 1990, 92%, or about $73 billion, of the waste management industry's overall revenue came from treatment and disposal activities.[32] More than 3,000 firms were involved in treating, storing, recycling, or disposing of the 345 million tons of hazardous waste created that year.[33] Wastes were treated in wastewater treatment centers, disposed of via deepwell injection, destroyed through high-temperature combustion (incineration), or buried in landfills.

Hazardous waste generators initially favored landfill disposal for hazardous waste. However, the 1984 RCRA amendments required EPA to set higher treatment standards for wastes disposed in landfills. As a result, the EPA prohibited the use of landfill disposal for many wastes and required that many other wastes be treated or stabilized before disposal. These requirements led to higher generator costs and new permitting requirements for landfills, thus discouraging their use after 1984. Landfills were also under attack by community activists and environmentalists opposed to the construction of new facilities with their community (this phenomenon has been dubbed the NIMBY—not in my back yard—syndrome). By some estimates, 1,200 of 1,500 landfill sites in the United States opted to close rather than comply with the so-called "land ban."[34]

Superfund program requirements also shifted the treatment preference away from landfills. Early Superfund cleanups involved either the removal of wastes from contaminated sites and subsequent placement of the wastes in an approved landfill facility or the containment of the wastes in the original site through the construction of an impermeable cover and a drain system to catch and treat site runoff (termed "cap-and-contain"). However, the Superfund Amendments and Reauthorization Act of 1986 developed stringent cleanup standards with a preference for permanent solutions that significantly reduced waste volume, toxicity, or mobility and encouraged alternatives to land disposal.

Molten Metal entered the market during this time of increasing regulatory oversight, intense industry competition, and heightened interest in environmental solutions. Armed with a technology it described as the most innovative of its class and able to go beyond the traditional paradigm of stabilization or simple destruction, MMT set off to capture waste management opportunities. MMT promoted its CEP technology on its regulatory and environmental merits, claiming that it avoided the environmental pitfalls of incineration and landfilling waste, while also sheltering MMT and the end-users from regulatory oversight because of the recycling nature of the process. [35] But other technologies offered considerable competition. The first and foremost was incineration, which was used at 30 percent of Superfund site cleanups in 1989.[36]

***Competing Technologies***

**Incineration** used temperatures exceeding 2,200ºF to heat and convert the waste stream into gases. The gases were then processed so that the organic compounds began to break down and remix with oxygen to form carbon dioxide and water, while inorganic material was changed into ash. This ash, as well as wastes created by scrubbers or filters used to treat the flue gases before being emitted into the atmosphere, contained hazardous constituents that required landfilling or retreatment.[37] By 1985, EPA reported that 90% of the hazardous waste incinerator capacity in the United States was used.[38] In response, an eight-fold increase in incineration capacity was constructed in the late 1980s. Continued expansion strategies were mixed with some groups, such as Rollins Environmental, expecting 20 to 25% annual growth through 1993 while others, such as CWM, saw a maturing market and predicted slower growth of around 10% per year.[39]

By 1989, public concern for the environment had reached unprecedented levels. Even *Time* magazine decided to forgo its standard man or woman of the year, opting to highlight the endangered Earth as "planet of the year."[40] And as a target for this growing concern, the construction of incinerators began to come under the same NIMBY attacks that landfills had experienced in earlier years. (See Exhibit 4) Grassroots groups acted as vigilant and vocal watchdogs over waste management procedures, and incineration was not viewed favorably by these groups. Responding to this public concern, EPA Administrator Carol Browner proposed a "combustion policy" that would reduce incentives for incineration and encourage recycling technologies (such as CEP). Despite such public and government opposition, incineration remained an attractive option. By 1995, expansion had increased incineration capacity to 1 million tons per year while demand lagged at 600,000 tons.[41] This excess capacity drove down prices, making the economics of incineration a formidable market force.

But as incinerators attempted to fill this capacity amidst continued public criticism, alternatives that sought to reduce or detoxify hazardous wastes began to gain favor—especially recycling. A further incentive to pursue recycling technologies was a loophole in the RCRA rules that exempted recycled waste from stringent regulatory standards (such as a Part-B permit). As a result, a niche market emerged to challenge conventional hazardous waste incineration methods with more environmentally innovative methods. To encourage entrepreneurial endeavors, DOE spent $2.8 billion to subsidize 780 new technologies aimed at aiding in the remediation of radioactive and hazardous waste deposits. Between the DOD and DOE, the federal government spent nearly $8 billion a year on waste management and cleanup programs.[42] Several technologies were attempting to carve out a piece of the market for themselves.

For example, *Commodore Separation Technologies* (Kennesaw, GA) offered a competing SLiM ™ process, based on a supported **liquid membrane separation technology**, which was capable of selectively removing — for recycle or disposal — materials from aqueous based solutions in both private or public sector industries. The advantage of such separation techniques was that they could remove contaminants from large volumes of groundwater or standing water. However, they primarily separated and condensed hazardous contaminants. They did not detoxify or destroy them and, therefore, required a series of other treatment technologies. The SLiM ™ process technology was expected to have important applications in industries such as metal plating and finishing, mining, chemicals, and pharmaceuticals.

*Envirogen* (Lawrenceville, NJ) offered a full-range of in situ (on-site) and ex situ (off-site) **biological degradation** systems for the treatment of contaminated soil and groundwater streams. Biodegradation used bacteria, fungi, and/or microorganisms to detoxify or destroy hazardous compounds. Biodegradation was a low-cost alternative—less than $100 per ton compared to incineration, which could cost as much as $1,000 per ton.[43] The drawback was that the process was slow and in situ applications could guarantee complete site detoxification. To augment its technological services, Envirogen also offered full-service environmental consulting support, such as underground and aboveground storage tank management, site investigation expertise, a broad range of engineering and construction services, air permitting, and compliance management.

*Perma Fix Environmental Services, Inc.* (Gainesville, FL) offered two proprietary treatment processes that utilized a nonthermal **chemical treatment and solidification technology** to transform certain hazardous wastes into nonhazardous materials. Wastes were converted into a chemically stable form through the use of chemical reactions that changed the toxic components into new nontoxic compounds and stabilized them. A major drawback was that the technology required considerable additional materials and handling of the materials such that the weight and volume of the waste material could increase by as much as two times, thereby increasing handling and disposal costs. The company was aggressively positioning itself as a major player in two markets, nuclear mixed waste (waste that was both low-level radioactive and hazardous) and wastewater treatment. The process also had broad applications in the nuclear, biological and chemical weapon destruction and general waste markets. The company was working with the DOE's Lawrence Livermore Laboratory to develop the process and was also in the process of completing construction of a 1,200-ton-per-year commercial waste treatment unit in its Gainesville, Florida facility.

Success among these competing companies and their technologies was dependent upon several factors, some of which were common among all high technology start-ups and some of which were unique to the waste management industry. First, these technology developers faced financial and market risks. While large amounts of capital were necessary to develop and commercialize these technologies, the R&D programs become even more capital intensive during the long trials of process testing and demonstration to both potential clients and the government. Even if a technology looked promising in bench-scale testing, investors were critical of keeping the company afloat while it took the technology from laboratory to full scale and then to market. To appeal to commercial clients, the technology had to demonstrate its ability to destroy waste materials to the level required by law, with assurance that the material was destroyed and with it, the associated liabilities. While cost was an important factor in market acceptance, certainty of destruction and regulatory approval were paramount.

It was this last area that made the risks of waste treatment technology development unique. The market was driven by federal and state regulations. Any actions that a commercial client undertook to treat or dispose of current wastes or to detoxify past waste disposal sites had to abide by an RCRA Part-B permit or Superfund program approval respectively. These two programs had statutory preferences in technology, which have been changing over time. As discussed earlier, the 1986 Superfund amendments reestablished a statutory preference for permanent solutions that significantly reduced waste volume, toxicity, or mobility and that encouraged alternatives to land disposal. This shift effectively wiped out the market for contractors providing cap-and-contain technologies and opened up new markets for those being serviced by MMT, Perma-Fix, Envirogen, and Commodore. RCRA similarly has stated technology preferences, which it designated as "Best Demonstrated Available Technology" (BDAT) for the pretreatment and treatment of specific hazardous wastes. To obtain such status, companies had to provide highly detailed demonstration tests that exhibited the capabilities of the technology under a variety of conditions and with a variety of waste streams. This regulatory approval process was critical to the success of waste management technologies and could take as long as 4 years.

## Molten Metal Technology, Inc.

With headquarters based in Waltham, Massachusetts, Molten Metal's initial target markets fell into three categories:
(1) industrial and hazardous wastes,
(2) commercial low-level radioactive wastes, and
(3) government waste. (See Exhibit 5)

**Industrial and hazardous wastes** meant that the company worked with private clients who were dealing with wastes from industrial processes (regulated by RCRA) or from the cleanup of historic hazardous waste sites (regulated under Superfund). EPA estimated that more than 208 million tons of waste were treated annually and waste site cleanups were expected to increase as the Superfund expanded its universe of activities. **Commercial low-level radioactive waste** (LLRW) also involved private clients, primarily nuclear power plants and medical and research facilities. The global LLRW market was estimated at $2 billion annually. **Government waste** included mixed wastes for DOE, chemical weapons wastes for DOD, and LLRW for the U.S. Enrichment Corp. (USEC). The company made an explicit choice to forgo the already crowded field of competitors around Superfund cleanup work and focus more on the LLRW and hazardous waste markets, for both private and government clients. Private clients were attractive because of their ability to process contracts more quickly than the government, which sometimes took as long as 4 years to move from contract bid to actual work activity. But the government was by far the largest consumer of environmental goods and services, with annual expenditures exceeding $8 billion in 1994 alone. This broad target market included accessing both cleanup contracts and research grants. This approach met with mixed reviews on Wall Street as some suggested that it lacked focus and others suggested that it expanded the profit potential. The government component of the strategy paid off early with research contracts and grants. Over the entire life of the company, MMT raised $33 million in federal support from the DOE.

### *Capital Expansion*

To demonstrate CEP to customers, regulators, and communities, MMT invested more than $25 million into its "Recycling Research and Development Facility" in Fall River, Massachusetts. Completed in 1992, the 86,000-square-foot facility was equipped with several CEP units, including three commercial-scale systems, the largest of which began operation in 1993 and could recycle up to 2 tons of waste per hour. Exhibit 6 provides an overview of the facility. While some viewed $25 million as an exorbitant expense for a prototype, others applauded Haney and Nagel. One analyst noted that MMT "pursued a smart strategy of building its own facility to demonstrate the technology."[44] Data from the facility led to the July 1995 decision by the U.S. EPA to recognize CEP as satisfying best demonstrated available technology (BDAT) requirements for chlorinated wastes from a variety of industrial processes. State regulators in Texas, Massachusetts, and Ohio similarly recognized CEP as an innovative technology for recycling. An exuberant Haney responded, "Because CEP is a pollution prevention technology that does not release harmful emissions, it is superior to conventional processes, and we plan to roll out CEP systems to handle the world's most challenging chlorinated wastes including PCBs, CFCs, pulp and paper sludges, chemical weapons, and medical wastes."[45]

Haney also sought partnership contracts with high-profile industrial partners. In 1992, MMT received a commitment for assistance from **Fluor Daniel, Inc.** (an international engineering and construction firm) to provide sole-source engineering, procurement, construction, and implementation services for commercial CEP units.[46] In return, Fluor Daniel received equity of $1.2 million in common stock with an option for an additional $4 million in successive years based on continued engineering services. Similarly, the company exchanged equity with **E.I. DuPont de Nemours Co.** to fund the initial pilot plant in Fall River, Massachusetts. The company anticipated that capital costs for future CEP systems would range from $15 million to $35 million per system,[47] which it claimed was half the cost of a comparably sized incinerator with an operating cost one third that of an incinerator.[48]

In 1994, the company formed a limited partnership called M4 Environmental LP with leading government contractor **Lockheed Martin** (the world's largest aerospace and electronics company). With each company owning 50%, M4 combined MMT's technology with Lockheed Martin's technical resources, market access, and waste handling and safety expertise. The partnership was granted an exclusive license to use the technology and to sublicense the technology to qualified third parties for use in the market. The partnership paid MMT $7.5 million in licensing fees in 1994 and $6.5 million in 1995. With Lockheed Martin committing up to $50 million to the new venture, M4's first project was to construct a $13.5 million privatized commercial plant at Commerce Park in Oak Ridge, Tennessee (known as the M4 Technology Center), that would utilize Quantum-CEP to process radioactive, mixed, and hazardous wastes. In conjunction with Batelle Memorial Institute and Bechtel National Inc., M4 began demonstration programs to test Q-CEP's ability to process bulk chemical agents stockpiled by the U.S. Army as well as mixed hazardous and radioactive waste for DOE.

In other business relationships, MMT partnered with:

- **Westinghouse Scientific Ecology Group** (SEG) (the world's largest processor of low-level radioactive waste) to form a limited partnership called MMT Tennessee, which would build an 80,000-cubic-feet-per-year unit, also in Oak Ridge, Tennessee, on Bear Creek Road. MMT Tennessee would process ion exchange resin, an LLRW generated by nuclear facilities;
- **Hoescht Celanese** (the U.S. arm of the world's largest chemical enterprise) to build, own, and operate a 20,000-ton-per-year CEP unit in Bay City, Texas, to process biosolids, a waste water treatment byproduct generated at Hoescht Celanese's gulf coast chemical plants; and
- **Rollins Environmental** (the largest commercial hazardous waste incineration company in the United States), to license the company's technology for CEP systems at any of Rollins' three hazardous waste processing facilities existing in 1992. Under the terms of the contract, Rollins paid MMT $50,000 per month for two years beginning September 1, 1992, and MMT provided research and development and other services to Rollins.

Such relationships were announced in frequent press releases from the company. While these agreements resulted in significant funding commitments and fueled investor optimism, some critics voiced concern. *Forbes* reported that several Molten press releases were denied or strongly watered down by the companies touted as partners.[49]

## MMT Contracts[50]

| | MMT Tennessee (Westinghouse SEG) | M-4 Environmental LP (Lockheed-Martin) | Hoescht-Celanese | Rollins Environmental |
|---|---|---|---|---|
| Unit type | Q-CEP | Q-CEP | CEP | CEP |
| Deal structure | 50/50 JV | Partnership | Own/Operate | License |
| Expected startup | 3Q95 | 1Q96 | 3Q96 | 4Q96 |
| Waste market | Commercial and government LLRW and mixed wastes | Commercial and government LLRW and mixed wastes | Industrial and hazardous waste | Industrial and hazardous waste |
| Process capacity[1] | 80,000[2] | 40,000 | 20,000 | 30,000 |
| Location | Bear Creek Road Oak Ridge, Tennessee | Commerce Park Oak Ridge, Tennessee | Bay City, Texas | not yet decided |

Notes:
1. Measured in cubic feet per year for Q-CEP and tons per year for CEP (1 ton = 40,000 cf).
2. Capacity expected to double by 1997.

### *Organization*

From 1989 to 1995, the company added staff rapidly attracting young and talented people who were energized by the exciting growth potential of the company and the important social benefits of the technology's solution to the world's hazardous and nuclear waste problems. With aggressive stock option plans and the promotion potential of a rapidly expanding company, MMT attracted experienced technologists, many of them operating engineers from the nuclear, chemical and metallurgical industries, as well as design and construction engineers with experience building first-of-a-kind facilities. A problem that continually plagued the growing company, however, was the constant need for new personnel to head up new areas. The company was often scrambling to fill capabilities that they were lacking.

To build on the enthusiasm of this select group of professionals, Haney sought to make the work environment relaxed and fun. Part of the company's 5-point mission statement stated that, "We will cultivate a working environment where we have fun while being challenged and rewarded."[51] (See Exhibit 7) Haney and Nagel seemed to embody this promise. The working environment at MMT was fun and informal, as evidenced by the typical jeans and tee-shirt wardrobe and the ping-pong table found outside of Bill Haney's office.[52] The company's roughly 500 employees shared their founders' visions of "environmental revolution," and the employee stock ownership plan (ESOP) helped cement their commitment to that vision. By 1994, almost 2.5% (500,000) shares of the company's approximately 21 million shares outstanding were designated for the ESOP. A long-term incentive plan, under which the board could grant incentive stock options to employees and directors of MMT also existed, tying rewards for individual employee and board governance performance to the firm's success.

MMT used information technology to make work tasks easier to manage and access to information more simple and efficient. For example, the company increased efficiency and lowered costs by employing an electronic workflow and document management system which (a) provided security for the company's patents and confidential data, (b) stored drawings and plans electronically, and (c) was also compatible with MMT's other computer systems. Information systems also handled workflows and approval procedures[53] and tracked the many waste samples associated with CEP processes. The company estimated that its bar-code-based data and collection management system at its Fall River, Massachusetts operation saved more than 90 labor days annually when compared with manual tracking processes.[54]

***Finance***
To keep the company going during the research and development stage of the CEP process, continued capital was critical. Through 1995, the company had little difficulty obtaining it. When he met Chris Nagel, Bill Haney was well capitalized. His proceeds from the sale of FuelTech totaled $15 million.[55] During the company's first nine months of existence, over $2.3 million in additional capital was raised.[56] Many outside observers were not surprised. Haney was well connected and viewed as a "favorite son of the investment community." Others stated that, in addition to the firm's technology, "at least as important is the prowess of the firm's cofounder, 30-year-old President William Haney." He was characterized by one industry analyst as being "extremely skilled at raising money and convincing the world that the technology works."[57]

Haney parlayed this into significant investments through private placements. In addition to its partnerships with DuPont, Fluor Daniel, Lockheed Martin, Westinghouse, Rollins, and Hoescht Celanese, Haney recruited Canadian industrialist (and former Secretary General of the 1992 United Nations Earth Summit) Maurice F. Strong to invest in MMT and to serve on the company's board. The venture capital unit of Travelers Insurance also provided Molten with $15 million in seed money.[58] In February 1993, the company issued its first public offering of stock at a per-share price of $14. The initial public offering (IPO) put another $80 million in MMT's coffers.[59] In a matter of weeks, the company's stock was trading in the 20s. The company's EPS and per-share prices are reported in Exhibits 1 and 2.

Analysts, over time, began to characterize the company's stock as "a locus for 'hot money' . . . speculators who want a quick and rapid return, irrespective of what business a company is in."[60] This attention to an environmental technology was contrary to the rest of the environmental technology field during the mid 1990s. Several leading mutual fund companies, for example, dropped environmental sector funds when investors became disillusioned. John Hancock, for one, folded its "envirofund" into of one its larger funds.[61]

***Government Relations***
Keenly aware of the importance of the government market, Haney focused considerable effort in making MMT known to key government officials and agencies. With the help of Peter Knight, Washington lobbyist and former chief of staff to Vice President Gore, MMT successfully pursued federal grants, awarded by DOE "so that Molten Metal's potentially broad applications can be demonstrated at the earliest possible opportunity."[62] Knight encouraged the company to raise its political profile on both sides of the political aisle. From 1994 to 1997, MMT donated more than $65,000 to the Democratic party and $67,000 to the Republican party, with an additional several thousand dollars originating from personal donations by employees. Additional funds, estimated at between $50,000 and $132,000, were raised by MMT for the 1996 Clinton-Gore reelection campaign.[63]

From the first grant of $1.2 million awarded during the Bush administration, MMT eventually secured $33 million in government contracts, matching $22 million of its own money for the technology's development. In 1994, CEO Bill Haney indicated that he expected MMT to derive 20 percent of its revenue for the next 10 years from the U.S. government.[64] Of comparable value were the high-profile accolades from government agencies and officials for the company's cutting edge technology. In April 1995, Vice President Al Gore, a personal friend of company executives and lobbyists, made MMT the focus of his Earth Day festivities by visiting the company's Fall River, Massachusetts Recycling-Research and Development Facility and endorsing CEP as "a shining example of American ingenuity, hard work, and business know-how."[65] Other high-level government supporters included Julie Belaga, a director of the Export-Import Bank. Belaga counted herself as an early guardian angel of MMT during her tenure as an EPA administrator in New England under the Reagan and Bush administrations.[66]

### *Operational and Financial Results*

By 1995, the company realized its first profit. (See Exhibit 2) Revenues increased to more than $44 million through an increase in engineering and construction activities in connection with the development of CEP systems for M4, an increase in licensing fees from M4, the performance of Technology Development Programs (TDPs), and collaborative research arrangements and grants. TDPs provided a customer with the opportunity to evaluate the performance of CEP on a specific waste stream before committing to full-scale operations. Sixty-nine percent of the revenue stream was attributed to M4 and 30% to DOE activity. Also assisting in revenue stream growth were decreases in research and development, and selling, general and administrative expenses that were the result of increased customer funding. These expenses are included in the cost of revenue.

Funds raised by the company were geared toward commercialization, and were used primarily for the design, construction and operation of commercial CEP systems, research and development, capital expenditures, the development of sales and marketing capabilities and intellectual property development and acquisition. While TDPs would continue to be a major source of revenue, analysts predicted that, with full commercialization, revenue would grow to $74 million in 1996 and $173 million in 1998. Net income was also forecast to grow from $355,000 in 1995 to more than $12 million in 1996 and $62 million in 1998. Based on projections shown in Exhibit 8, Alex Brown and Sons recommended the company as a "strong buy" investment rating to its investment clients. Haney was very focused on such ratings, using his exceptional marketing and interpersonal skills with market analysts to personally tell his firm's story.

Growth estimates were driven by the expectation of commercialization of the technology in late 1995 or early 1996 and the further penetration of public, private, and international markets thereafter. Wall Street analysts warned, however, that the uncertainty in these forecasts centered on timing issues (start-up delays at plants) rather than technology issues. The fact was that most of Molten Metal's revenues had been realized through grants and licensing fees. Without commercial plants going on-line and generating operating revenues, analysts believed that these forecasts would not be supported.[67] Some expressed concern, suggesting that the company might not be able to match the hype by the Clinton Administration and Wall Street analysts. Phil Barton, manager of the Fidelity Select Environmental Services Fund warned, "It's an interesting technology, but the risks are too high to justify a $500 million market cap."[68]

### *Next Steps*

With a promising technology, three commercial plants ramping up in Texas and Tennessee, strong and diverse ties throughout industry and government, and soaring stock prices, MMT faced a bright future. Haney reported that, "Taken together, the achievements of 1994 have positioned us to successfully start up our first commercial systems in 1995 and rapidly expand worldwide thereafter." Commercial-scale tests at the Fall River R&D facility had achieved 99.99999% destruction efficiency in converting wastes into usable materials (gases such as high-purity hydrogen, nitrogen, and carbon monoxide gas solids including calcium chloride and iron-nickel alloys).[69] But, as of September 1995, commercial implementation was still not a reality. Alex Brown and Sons predicted that the transition to commercial operations was still 12 to 15 months away. Steve Lerner, of the *Amicus Journal*, warned, "There is no definitive answer yet on just how closely the results match theory at MMT, and independent environmental specialists are far from seeing eye to eye on it."[70]

Uncertainties lay ahead. What would happen if commercial start-up was delayed? How long could the company support its simultaneous ramp-up at three commercial facilities? Would its financial ties in industry and government secure the entire operation's future? Would the new technology find favor with regulators? Would it be attractive to commercial and government clients? How did it match up against competitors? Once commercialized, which of the three markets held the most promise? Was it wise to target all three? Were there other markets that could be lucrative?

## Notes


1. J. Sheridan (1993) "Technology of the year: Molten Metal Technology Inc., Catalytic extraction process converts hazardous and toxic wastes into valuable materials," *Industry Week,* December 20:34.
2. C. Nagel, C. Chanenchuk, E. Wong and R. Bach (1996) "Catalytic extraction processing: An elemental recycling technology," *Environmental Science & Technology,* 30(7):2155–2167.
3. C. Mouche (1997) "Cleaning up the cold war legacy," *Pollution Engineering,* February: 40–42.
4. _______ (1993) "Waste management: Hot solution," *The Economist,* July 10/16:78.
5. Waste is considered hazardous under the Resource Conservation and Recovery Act (RCRA) if it is ignitable, reactive, corrosive, or toxic.
6. Molten Metal Technology (1994) *Key Biographies,* company literature, August (Waltham, MA.)
7. J. Sheridan. (1993).
8. Molten Metal Technology (1994) *Annual Report* (Waltham, MA.).
9. M. Maremont (1994) "The hot tandem at Molten Metal," *Business Week.* June 27:54.
10. M. Maremont (1994).
11. J. Sheridan (1993).
12. M. Maremont (1994):55.
13. M. Maremont (1994).
14. Molten Metal Technology (1994) *Key Biographies.*
15. St. Lerner (1995) "Heavy metal," *The Amicus Journal,* Winter: 31
16. D. Machan (1996) "The Veep's pal," *Forbes,* January 22:60.
17. M. Maremont (1994):55.
18. J. Smith (1991) "Molten Metal Technology," *EI Digest,* July: 8–13
19. J. Smith (1991).
20. J. Smith (1991).
21. 42 U.S.C. s/s 321 et seq. (1976).
22. 42 U.S.C. s/s 9601 et seq. (1980).
23. A. Hoffman (1995) "An uneasy rebirth at Love Canal," *Environment,* 37(2):4–9, 25–31.
24. M. Haney and J. Casler (1990) *RCRA Handbook* (Acton, MA: ENSR Consulting and Engineering).
25. _______ (1981) *Hazardous Waste Market—Handling, Storage and Disposal,* (New York, NY: Frost and Sullivan Inc.) January: 24.
26. U.S. EPA Office of Solid Waste and Emergency Response (1990) *Superfund: Environmental Progress* (Washington DC: Government Printing Office).
27. _______ (1987) "Real property," *ABA Journal,* November 1: 67.
28. M. Russell, E. Colglazier, and B. Tonn (1992) "The US hazardous waste legacy," Environment, July/August, 12–15, 34–39.
29. U.S. Department of Energy (1990) *Environmental Restoration and Waste Management, Five Year Plan 1992-1996.* (Washington DC: Government Printing Office).
30. Con Solve, Inc. (1991) *Hazardous Waste Market Report* (Lexington, MA: Con Solve Inc.)
31. Waste Management Inc. (1990) *Annual Report, 10-K Report*.
32. L. Noll (1990) "A competitive analysis of hazardous waste management," *Leading Edge Reports,* December: 9.
33. _______ (1991) "Hazardous waste industry grows with public concern," *Chemical Marketing Reporter,* January 28:9.
34. H. Tilton (1989) "Hazardous waste universe expanding," *Chemical Marketing Reporter,* December 11: SR3.
35. D. Swindell (1995) *Investment Analysis: Molten Metal Technology, Inc.* (MLTN) May 24 (Baltimore, MD: Alex Brown & Sons Incorporated).
36. U.S. EPA Office of Emergency and Remedial Response (1990) *ROD Annual Report: FY 1989,* (Washington DC: Government Printing Office).
37. A. Hoffman (1992) *The Hazardous Waste Remediation Market: Innovative Technological Development, and the Market Entry of the Construction Industry,* CCRE Working Paper No. 92–1 (Cambridge, MA.: M.I.T. Department of Civil and Environmental Engineering).
38. _______ (1987) "New waste management capacity may not be needed, study shows," *Rachel's Hazardous Waste News #23,* May 4:1.
39. A. Loesel (1990) "Incinerator operators push for equilibrium," *Chemical Marketing Reporter,* December 10: SR21.

40. R. Miller (1989) “Earth is chosen as Time’s planet of the year,” *Time,* January 2:3.
41. K. Welling (1995) “Bah, humbug,” *Barron’s,* December 25:3.
42. Molten Metal Technology (1994) *Annual Report* (Waltham, MA.).
43. _______ (1990) “The tiniest toxic avengers,” *Business Week,* June 4:96.
44. T. Barron (1993) “Molten Metals: Good technology, good PR, or both?” *Environment Today,* November: 3.
45. Molten Metal Technology (1995) Press Release, July 20, (Waltham, MA.).
46. M. Maremont (1994).
47. Molten Metal Technology (1994) *Annual Report.*
48. *The Economist* (1993).
49. D. Machan (1996).
50. D. Swindell (1995).
51. Molten Metal Technology (1994) Company publications (Waltham, MA.).
52. M. Maremont (1994).
53. _______ (1996) “Workflow brings records under control,” *Managing Office Technology,* January: 48.
54. _______ (1997) “Bar codes trim time and costs of tracking hazardous materials,” *Modern Materials Handling,* August: S13.
55. M. Maremont (1994).
56. E. Kiesche, A. Lucas, D. Hunter, and D. Jackson (1993) “Hot prospects,” *Chemical Week,* December 22: 29.
57. T. Barron (1993): 3–4.
58. M. Maremont (1994).
59. S. Lerner (1995).
60. T. Goetz (1997):42–43.
61. J. McTague (1994) “Smoke and mirrors,” *Barron’s,* November 28:31–32.
62. D. Machan (1996).
63. M. Kranish (1997) “Mass firm with ties to Gore got grants: Key figures linked by years at Harvard,” *The Boston Globe,* September 11: A1.
64. J. McTague. (1994).
65. D. Machan (1996).
66. J. McTague (1994).
67. D. Swindell (1995).
68. M. Maremont (1994):55.
69. J. Sheridan (1993).
70. S. Lerner (1995): 4–10.

**Exhibit 1: MMT Stock Performance, 1995**

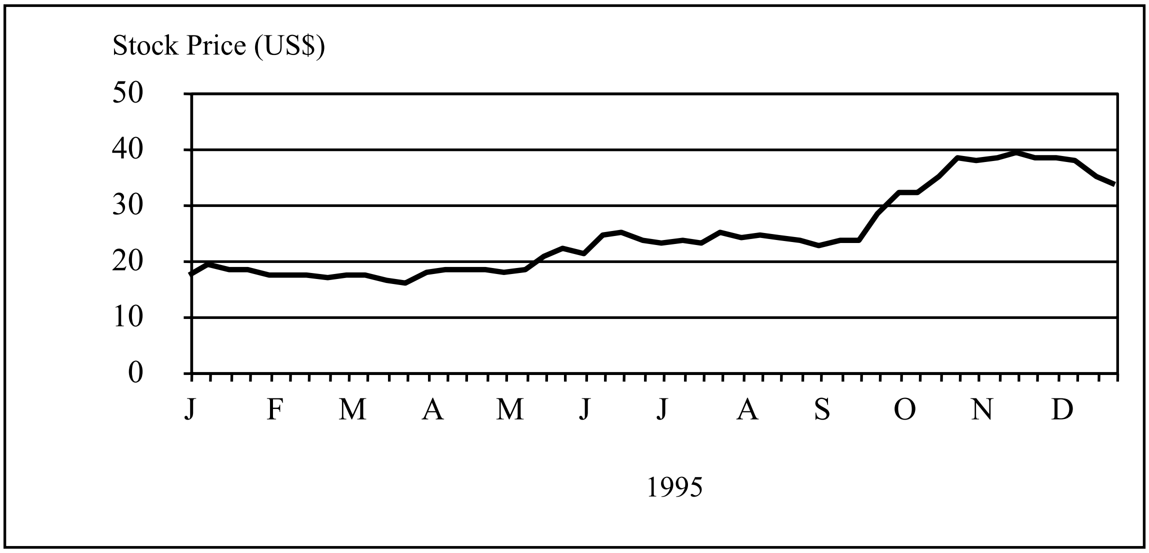



**Exhibit 2: MMT Financial Data**

**(a) Consolidated Statement of Operations (thousands)**

| | Year Ended December 31 | | | | | |
|---|---|---|---|---|---|---|
| | **1995**[1] | **1994**[2] | **1993** | **1992** | **1991** | **1990** |
| **Revenue** | $44,181 | $14,398 | $4,721 | $2,526 | $1,960 | — |
| Cost of revenue | 34,900 | 11,057 | 2,205 | 2,172 | 1,177 | — |
| | 9,281 | 3,341 | 2,516 | 353 | 782 | — |
| **Operating expenses** | | | | | | |
| Research and development | 10,986 | 14,417 | 10,837 | 4,208 | 574 | 1,839 |
| SG & A | 2,877 | 7,131 | 5,661 | 4,132 | 1,117 | 76 |
| | 13,736 | 21,549 | 16,499 | 8,341 | 1,691 | 1,915 |
| Gain (loss) from operations | (4,584) | (18,207) | (13,982) | (7,987) | (909) | (1,915) |
| Other income (expense) | | | | | | |
| Interest income | 5,600 | 4,376 | 1,861 | 400 | 323 | 59 |
| Interest expense | (1,455) | (737) | (160) | (16) | (18) | (10) |
| Equity income from affiliate | 834 | — | — | — | — | — |
| Net gain (loss) | 355 | (14,569) | (12,281) | (7,603) | (603) | (1,866) |
| Weighted average common shares outstanding | 24,710 | 21,904 | 17,811 | 12,843 | 12,652 | 9,279 |
| **Net gain (loss) per share** | 0.01 | (0.67) | (0.69) | (0.59) | (0.05) | (0.20) |

Notes:
1. 1995 Data source: Molten Metal Technology. 1997. *10-K Report* (Waltham, MA).
2. 1990–1994 Data source: Molten Metal Technology. 1994. *Annual Report* (Waltham, MA).

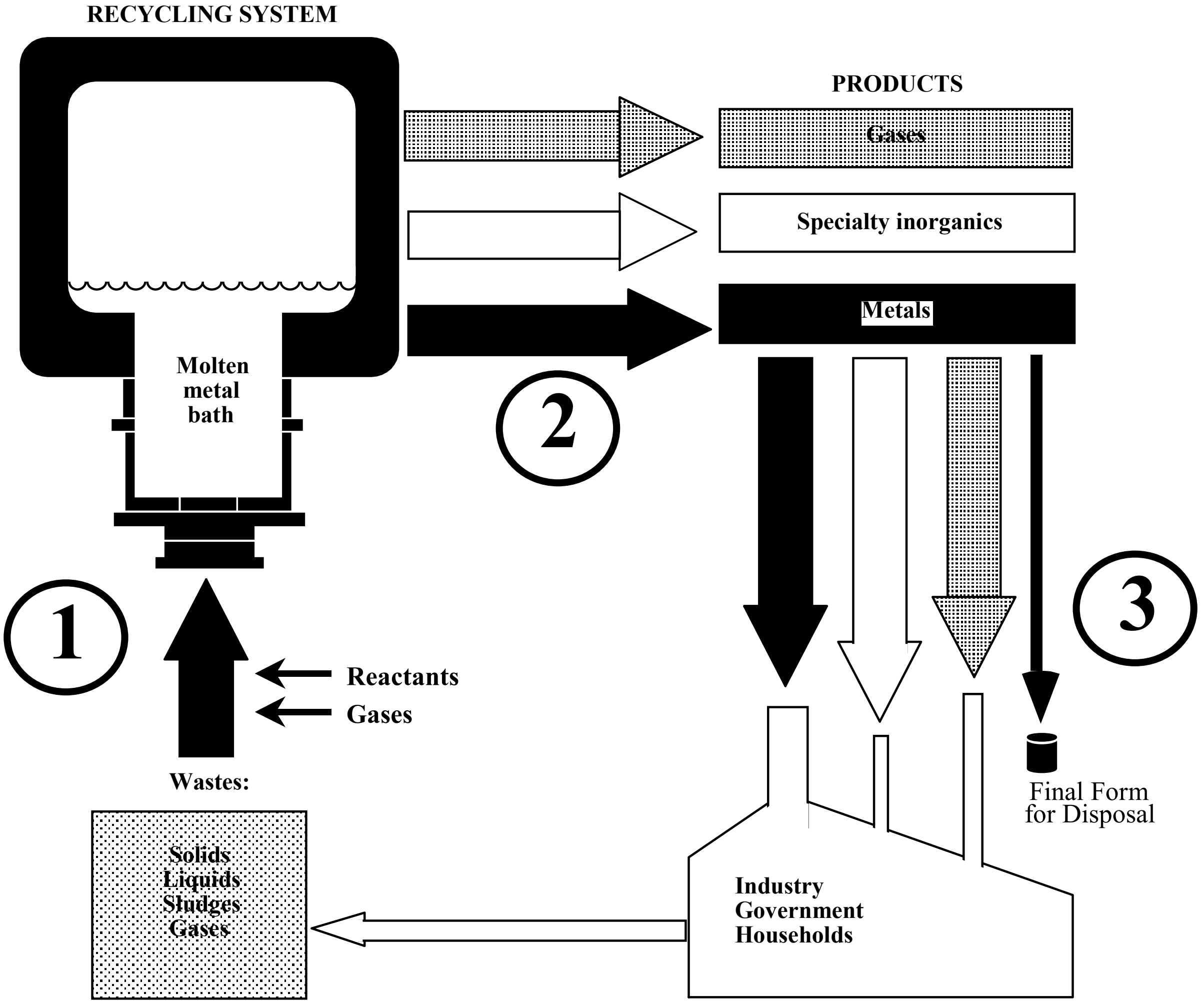
## Exhibit 2: MMT Financial Data, continued

## (b) Consolidated Balance Sheet (thousands)

| | December 31 | | |
|---|---|---|---|
| | 1995[1] | 1994[2] | 1993 |
| **Assets** | | | |
| Current assets: | | | |
| Cash and cash equivalents | $6,644 | $12,063 | $32,536 |
| Short-term investments | 79,631 | 88,132 | 71,887 |
| Accounts receivable | 17,330 | 2,157 | 1,717 |
| Prepaid expenses and other current assets | 2,309 | 1,821 | 1,218 |
| Total current assets | 105,915 | 104,174 | 107,359 |
| Restricted cash and investments | 7,432 | 9,871 | 585 |
| Fixed assets, net | 34,679 | 18,120 | 13,180 |
| Intangible assets, net | 3,501 | 2,402 | 2,086 |
| Other assets | 1 ,806 | 972 | 416 |
| **Total assets** | **153,336** | **135,541** | **123,628** |
| **Liabilities and stockholders' equity** | | | |
| Current liabilities: | | | |
| Current portion of long-term debt | 195 | 480 | 123 |
| Accounts payable | 9,827 | 1,656 | 2,917 |
| Accruals | 2,502 | 2,135 | 627 |
| Deferred revenue | 4,083 | 4,583 | — |
| Total current liabilities | 16,608 | 8,856 | 3,669 |
| Long-term debt | 22,883 | 23,075 | 2,150 |
| Due to related parties | 1,474 | 1,474 | 1,474 |
| Deferred income from affiliates | 2,459 | — | — |
| Equity investment in affiliates | — | — | — |
| Stockholders' equity: | | | |
| Preferred stock, $0.01 par value, 3,000 shares authorized, no shares issued or outstanding | — | — | — |
| Common stock, $0.01 par value, 40,000,000 shares authorized; shares issued and outstanding, 22,746,854 at December 31, 1995; 22,165,963 at December 31, 1994; and 21,740,927 at December 31, 1993 | 227 | 221 | 217 |
| Additional paid-in capital | 146,641 | 141,309 | 138,679 |
| Valuation allowance for short-term investments | (311) | (2,328) | — |
| Accumulated deficit (retained earnings) | (36,638) | (36,993) | (22,424) |
| Deferred compensation | (10) | (72) | (139) |
| Total stockholders' equity | 109,908 | 102,135 | 116,333 |
| **Total liabilities** | **153,336** | **135,541** | **123,628** |

Notes:
1. 1995 Data source: Molten Metal Technology. 1997. *10-K Report* (Waltham, MA).
2. 1993–1994 Data source: Molten Metal Technology. 1994. *Annual Report* (Waltham, MA).

**Exhibit 3: Catalytic Extraction Processing**




CEP uses molten metal to break down waste to its constituent elements. Waste materials are introduced into the recycling system (1) and with the addition of chemical reactants, the extremely high temperature of the molten metal bath causes the waste to separate into its basic components (2). These elements are reconfigured into valuable gases, ceramics, and metals that can be reused or sold as raw materials (3).

*Source:* Corcoran, E. 1994. "A waste not, want not goal: Fledgling firm takes a lesson from steelmakers to recycle industrial waste." *The Washington Post*, February 22: E1, E4; and Molten Metal Technology. 1994. *Annual Report* (Waltham, MA).

**Exhibit 4: Incineration Opposition**

HAZARDOUS WASTE

# Incinerators beseiged

Plans to build hazardous waste incinerators to handle Superfund-related waste in two states are threatened by stiff local opposition.

In Maryland, residents of St. Mary's County, along the Chesapeake Bay, are trying to reverse a 1988 U.S. Environmental Protection Agency plan for a $38-million incinerator to dispose of toxics from a Superfund cleanup site in Hollywood. They charge that EPA failed to fully inform or involve them in developing its "record of decision" outlining the site's cleanup strategy.

Leslie Brunker, remedial project manager in EPA's Philadelphia-based region, says the multi-year plan to incinerate 120,000 cu yd of creosote-contaminated soil and sludge and to pump and treat site groundwater had been "fully discussed" with local residents before the decision was signed. Brunker says EPA plans to complete the incinerator design next summer and seek bids for construction next fall. Burning would start in 1993.

But a spokeswoman for the opponents says they have already convinced county officials to ask EPA to stop ongoing test burns and reconsider alternatives to incineration, such as soil flushing or bioremediation.

Meanwhile, in Florida, a battle continues over a county ordinance that would bar siting of a proposed $150-million toxics incinerator in rural Madison County. It would be used by the state—and possibly some neighbors—to meet hazardous waste capacity assurance rules under Superfund. Florida now exports nearly 60,000 tons per year of waste out of state.

Waste-Tech Services Inc., a subsidiary of Amoco Oil Co. that wants to build the 70,000-tpy-facility, has filed suit in federal district court in Tallahassee to overturn the ban. County officials enacted it almost immediately after Waste-Tech filed for a state permit. The company hopes to begin construction in late 1993.

The county "is reflecting a lot of citizen concern over the safety of this type of facility," says Jay Landers, its special counsel. State environmental officials have yet to rule on Waste-Tech's permit, although they say they will reject the permit application for a separate privately-owned incinerator planned on the western side of the state. ▣



*Source:* "Incinerators besieged," *Engineering News Record*. 28 October 1991, p. 16.

## Exhibit 5: Molten Metal Technology Initial Target Markets

| Market Segment | Definition | Size and Scope | Drivers |
|---|---|---|---|
| 1. Commercial Low-Level Radioactive Waste (LLRW) | LLRW comprised any waste that came into contact with radioactivity that was not defined as high-level radioactive waste. LLRW was generated primarily by nuclear power plants and medical and research facilities. | • 4.0 million to 4.5 million cubic feet generated annually<br>• 50% by nuclear facilities.<br>• 35-45% landfilled, balance went through volume reduction treatments<br>• Global LLRW market was estimated at $2 billion annually. | • High costs of landfilling ($300 to $500 per $ft^3$)<br>• Lack of landfilling capacity<br>• States required to provide disposal capacity for LLRW generated within their borders<br>• Many states lacked the capability to provide these facilities. |
| 2. Government Mixed and LLRW Wastes | Included wastes generated by departments and agencies of the U. S. government. This included mixed wastes for the Dept. of Energy (DOE), chemical weapons wastes for the Dept. of Defense (DOD), and LLRW for the U. S. Enrichment Corp. (USEC). | • DOE: 29 million $ft^3$ of mixed waste in storage of which 9.4 million $ft^3$ is LLRW<br>• USEC: Generated 15,000 tons/year of depleted uranium hexafluoride (uranium tails). With 20,000 tons in existing storage.<br>• DOD and DOE had identified nearly 2,000 sites requiring environmental solutions such as CEP and together spent nearly $8 billion annually on waste management and cleanup. | • Same drivers as in segment #1.<br>• Budget constraints pressured government agencies to efficiently and economically dispose of wastes.<br>• Government placed high priority on treating stored wastes to reduce health and safety risks. |
| 3. Industrial & Hazardous Wastes | Industrial process waste material defined as "hazardous" by the EPA and thus, requiring permitted treatment and disposal. This material could originate from operating industrial processes regulated by RCRA or from the cleanup of an historic hazardous waste site under Superfund. | • EPA estimated over 208 million tons of waste treated annually.<br>• Superfund cleanup activity was expected to increase dramatically through the 1990s as both the pace of cleanups was increased and the universe of waste sites was expanded. | • Strong existing network of treatment and disposal facilities.<br>• Perceived demand for high quality products converted from waste streams. |

*Source:* Swindell, D. 1995. *Investment Analysis: Molten Metal Technology, Inc. (MLTN).* May 24 (Baltimore, MD: Alex Brown & Sons Incorporated).

## Exhibit 6: Molten Metal Technology Recycling-R&D Facility Overview

The Recycling R&D Facility showcases CEP for customers and regulators, and allows for ongoing process development. The facility houses state-of-the-art systems with advanced capabilities.

**Physical Models** allow design verification and visualization of transport phenomena for:

- Optimization of injection techniques
- Study of material mixing
- Evaluation of reactor geometries
- Simulation of foaming tendencies
- Development of continuous tapping techniques
- Design of prototype demonstrations

**Bench-scale System** experiments validate CEP feasibility for specific applications, allowing:

- Performance of basic material balances
- Quantification of material partitioning
- Analysis of primary off-gas constituents
- Creation of recoverable materials
- Destruction and Removal Efficiency (DRE) data
- Examination of heavy metals capture
- Determination of refractory durability
- Validation of modeling predictions
- Design of prototype demonstrations

**Prototype Unit** is a fully integrated, fully instrumented system that facilitates:

- Evaluation of commercial opportunities
- Quantification of material and energy balances
- Demonstration of long-term operation
  - Product recovery systems
  - Integrated control and safety systems
  - Gas handling trains
  - System maintenance problems
- Destruction and Removal Efficiency (DRE) data
- Commercial design and operations plan

*Source:* Molten Metal Technology. 1994. *Annual Report* (Waltham, MA).

**Exhibit 7: Molten Metal Technology Mission Statement**

***Mission:***

- Molten Metal Technology is dedicated to the development and worldwide implementation of innovative Elemental Recycling processes.
- We stand committed to the highest standards of integrity, safety, and environmental stewardship.
- We will provide unmatchable value and service to our customers.
- We will cultivate a working environment where we have fun while being challenged and rewarded.
- In achieving these goals, we will deliver extraordinary long-term growth in shareholder equity.

*Source:* Molten Metal Technology. 1994. *Annual Report* (Waltham, MA).

## Exhibit 8: MMT Financial Projections (dollars in millions, except per share amounts)

### INCOME MODEL

| | 1996E | 1997E | 1998E | 1999E | 2000E |
|---|---|---|---|---|---|
| **Revenue** | | | | | |
| Research revenue | $15.00 | $15.00 | $10.00 | $10.00 | $10.00 |
| Construction revenue | 30.00 | 45.00 | 75.00 | 90.00 | 90.00 |
| License/royalty fees | 12.30 | 12.52 | 18.44 | 31.96 | 57.20 |
| Process revenue | 16.88 | 37.00 | 69.50 | 121.50 | 193.00 |
| Total Revenue | 74.18 | 109.52 | 172.94 | 253.46 | 350.20 |
| Cost of revenue | 43.46 | 60.90 | 89.65 | 117.25 | 138.70 |
| **Gross profit** | 30.71 | 48.62 | 83.29 | 136.21 | 211.50 |
| Research & development | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| SG&A | 8.50 | 10.95 | 17.29 | 25.35 | 35.02 |
| **Operating income (loss)** | 12.21 | 27.67 | 56.00 | 100.86 | 166.48 |
| Equity in M4 joint venture | 0.00 | 17.29 | 45.64 | 82.74 | 130.69 |
| Interest expense | (3.00) | (5.50) | (8.50) | (10.00) | (12.50) |
| Interest income | 3.00 | 2.00 | 2.50 | 3.00 | 6.00 |
| Pretax Income (loss) | 12.21 | 41.46 | 95.63 | 176.60 | 290.67 |
| Income taxes | 0.00 | 14.51 | 33.47 | 61.81 | 101.73 |
| **Net income (loss)** | 12.21 | 26.95 | 62.16 | 114.79 | 188.93 |
| **Earnings (loss) per share** | $0.45 | $1.00 | $2.30 | $4.25 | $7.00 |
| Shares out (Fully diluted) | 27.00 | 27.00 | 27.00 | 27.00 | 27.00 |

*Source:* Swindell, D. 1995. *Investment Analysis: Molten Metal Technology, Inc. (MLTN).* May 24 (Baltimore, MD: Alex Brown & Sons Incorporated).