TABLE II

NEUTRON ASSAY SYSTEMS

Instrument or Technique	Operating Principle	Application
Random driver[a]	Am-Li source neutrons; fast coincidence detection of prompt neutrons	Fissile assay of Pu and highly enriched U; passive assay of ^{240}Pu and ^{242}Pu
^{252}Cf shuffler[b]	Cyclic irradiation with moderated ^{252}Cf neutrons; detection of fission delayed neutrons	Fissile assay of a wide range of U, Pu material categories
^{252}Cf fuel rod scanners[a]	Irradiation with moderated ^{252}Cf neutrons; detection of fission prompt neutrons, delayed neutrons, or delayed gamma rays	Fissile assay of FBR, LWR fuel rods
Antimony-beryllium[b]	Irradiation with Sb-Be photoneutrons; integral counting of fission prompt neutrons	Fissile assay of cold and spent fuels
Thermal-neutron coincidence counter[a]	Time-correlated detection of spontaneous fission neutrons with polyethylene-moderated ^{3}He well counter	Assay of ^{240}Pu, ^{242}Pu, and ^{239}Pu

[a]Well developed for many fuel cycle applications; instruments commercially available.

[b]Developed for some fuel cycle applications and being evaluated for others.

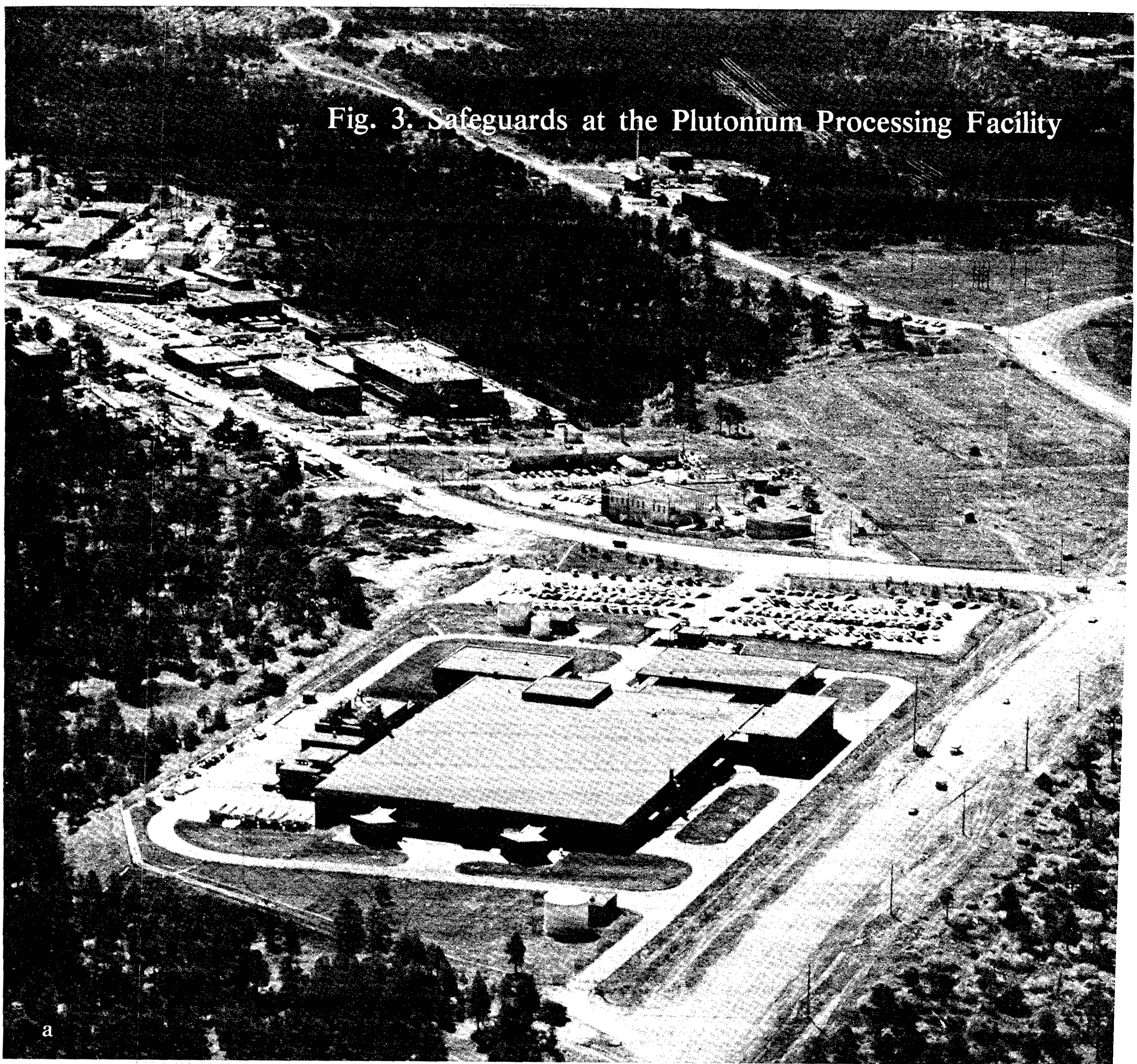
location and movement of all SNM can be localized in both space and time. Materials balances drawn around unit processes are called *near-real-time* or *dynamic* materials balances to distinguish them from conventional balances drawn after a shutdown, cleanout, and physical inventory.

In a direct application of the foregoing general principles, LASL is integrating newly developed NDA technology with automated data processing, monitoring and surveillance techniques, modern data base management, and decision analysis methods into an overall dynamic materials accountability system, called DYMAC. The system provides direct in-plant implementation of modern near-real-time accountability and control. A specific application of the DYMAC concept and associated safeguards technology at the LASL plutonium processing facility is shown in Fig. 3. To date, the DYMAC system at the LASL plutonium facility has completed over 100,000 material transactions with no significant errors or discrepancies.

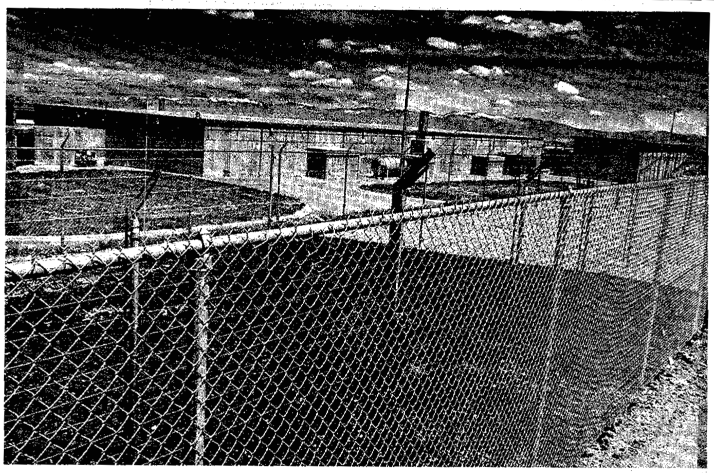
The least disruptive time to develop and evaluate new safeguards systems designs is before a facility is built, preferably at the conceptual-design stage. Accordingly, the LASL safeguards program has developed and evaluated conceptual designs of cost-effective integrated systems for most fuel-cycle facility types. Concepts, design criteria, and recommendations from the LASL effort are being increasingly implemented both domestically and internationally.* In addition, advanced materials accoun-

**See "Dynamic Materials Accounting Systems," in this issue.*

Fig. 3. Safeguards at the Plutonium Processing Facility



a



(a) The new LASL Plutonium Processing Facility is the large concrete structure in the left half of the photograph. Many proven security measures including fences, limited access, and alarms are employed to safeguard the facility. Other measures are so new they are in the demonstration stage, such as DYMAC, the dynamic materials accountability system that keeps track of the facility's inventory of nuclear material. Processing operations began here in January 1978. The facility now has over 6000 inventory items to safeguard.

(b)To study the effectiveness of various types of perimeter fences and intrusion devices, Sandia Corporation recently erected a 100-meter-long test bed outside part of the existing perimeter fence at the plutonium facility.

(c) *Security guards inspect all items that persons carry into the facility grounds and search vehicles entering and leaving the grounds with portable gamma meters developed at LASL.*

(d) *The two main entry points into the processing building are manned stations where persons exchange badges and pass through commercially available portal monitors, which detect radiation. The performance of the portal monitor is being evaluated.*

(e) *Inside the facility's vault, all items are stored in containers that have individual seals. Some of the vault spaces have LASL-developed shelf monitors that can detect whether a container or part of its contents has been removed.*

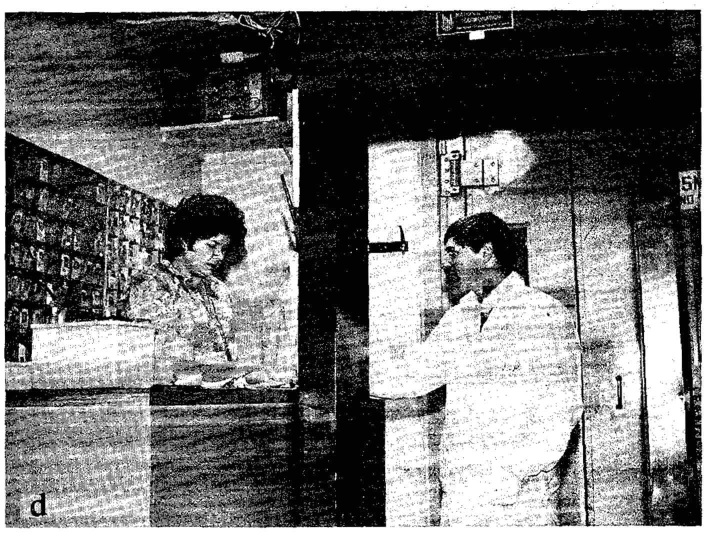
(f) *The Advanced Fuels process, one of 23 processes currently operating in the plutonium facility, produces fuel pellets for the FFTF (fast-flux test facility) reactor in Richland, Washington. The process constitutes one accountability area, within which seven subareas have been defined, each corresponding to a particular step in the fabrication process. A materials balance can be drawn around the entire process and around each subarea to determine exactly how much plutonium is present and where it is located.*

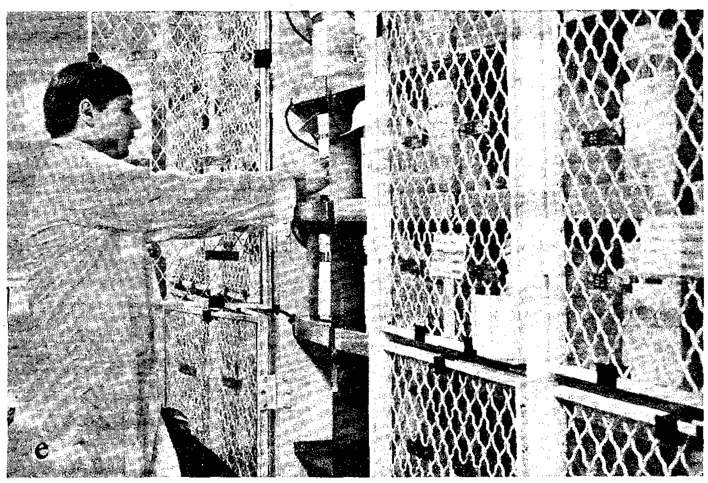
(g) *A technician uses a microprocessor control unit to control operation of the thermal neutron coincidence counter on top of the glove-box line. She is measuring the amount of plutonium in a batch of finished fuel pellets for a materials balance.*

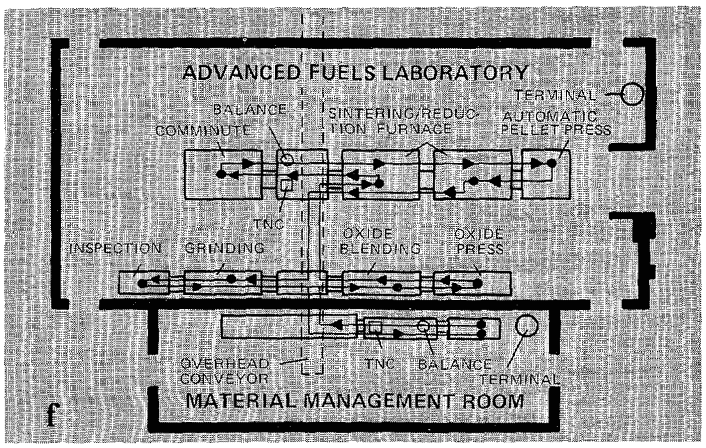
(h) *Following the measurement of finished fuel pellets, a technician makes a transaction to update the computer inventory with the correct amount of plutonium contained in the pellets.*

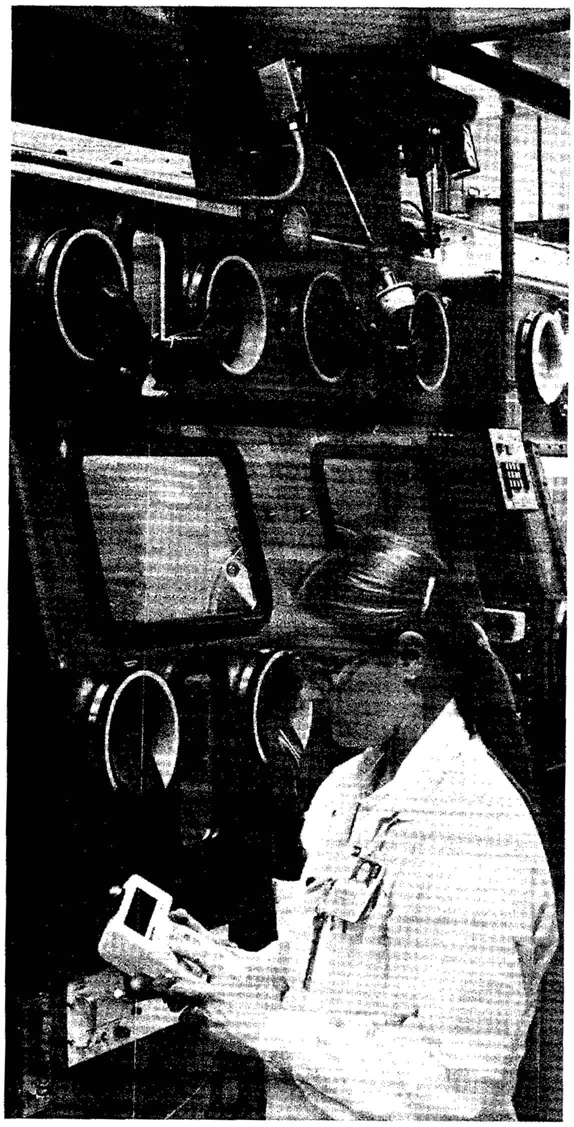
(i) *The central computer keeps track of the facility's inventory. It accumulates, sorts, and stores the information from individual transactions, and makes it available to any authorized requestor at a terminal. Programmers and computer operators in the DYMAC computer room keep a constant check on the system to make sure it is operating properly.*

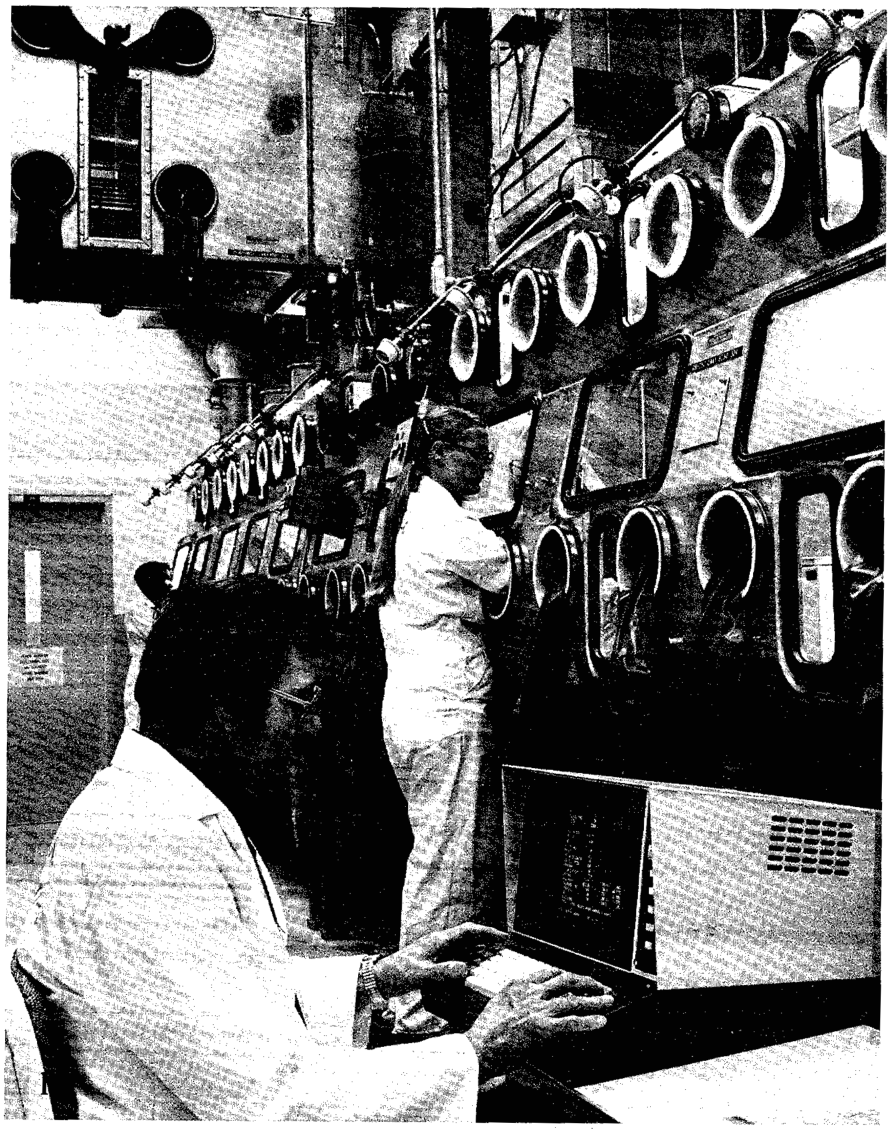
(j) *A materials balance is the difference between material introduced into a unit process and the material removed from the process. Results of material balancing for the sintering/reduction furnace in the Advanced Fuels process is shown on an MIP (material-in-process) chart. Small amounts of plutonium accumulate on the boats that transport the pellets into the furnace. The chart indicates the amount of plutonium that each batch contributes to the MIP buildup on the boats. When the MIP grew to about 80 g, the supervisor conducted a cleanout to recover as much plutonium as was practical. The plutonium recovered from the boats was measured with the thermal neutron coincidence counter and sent to scrap recovery.*

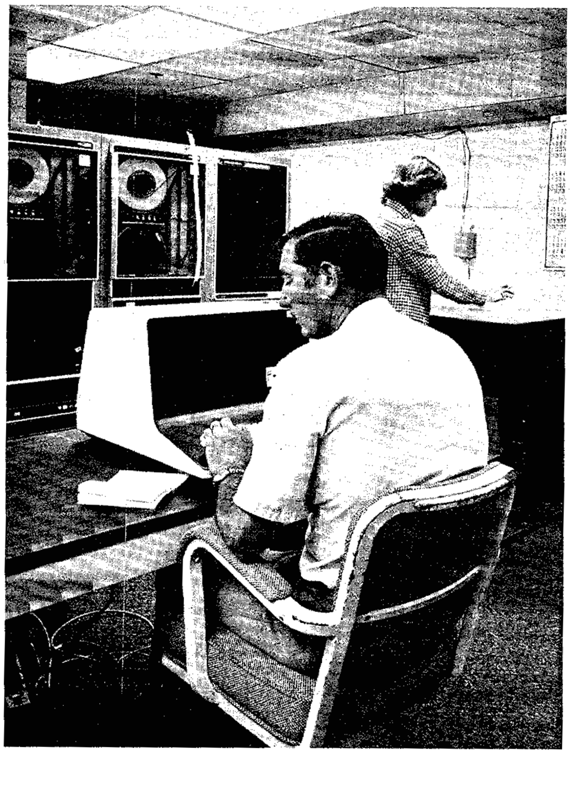


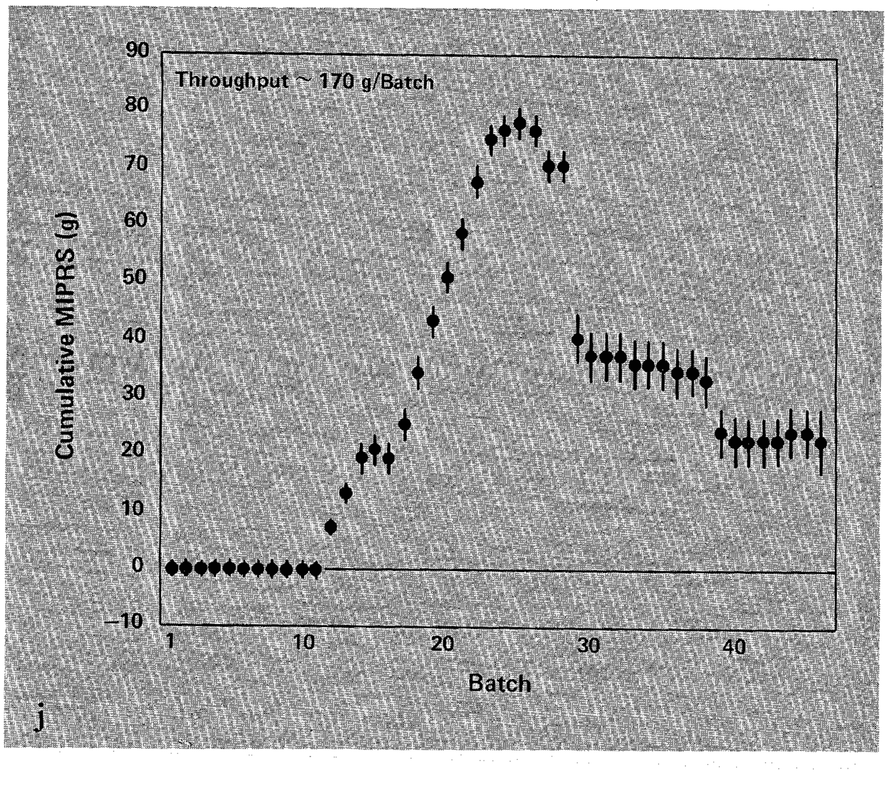








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Cumulative MIPRS (g)
90
80
70
60
50
40
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20
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Batch
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