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Strategic and Critical Non-Fuel Materials and the National Defense Stockpile

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PREFACE

This Document was prepared by the Institute for Defense Analyses for the Office of the Assistant Secretary of Defense (Economic Security), in partial fulfillment of the task order "National Defense Stockpile Analyses."

The authors wish to thank Mrs. Jackie Evans and Mrs. Barbara Varvaglione for help in preparing the manuscript, and Ms. Eileen Doherty for her thoughtful review of our efforts.

FOREWORD

The Strategy, Forces and Resources Division of the Institute for Defense Analyses holds weekly noon-time Seminars, presentations of the current research being performed by members of the Division staff. The primary purpose of these Seminars is to enrich the knowledge base of all members of the staff, and to stimulate creative thought. This IDA Document provides a record of one such presentation: Strategic and Critical Non-fuel Materials and the National Defense Stockpile.

CONTENTS

SUMMARY

Since June of 1988, the Institute for Defense Analyses has been assisting the Department of Defense in developing a systematic process to estimate U.S. stockpile requirements for strategic and critical materials. This annotated briefing provides a capsule history of the National Defense Stockpile of strategic and critical non–fuel materials, a review of requirements planning studies prior to IDA's involvement, and a summary of the NDS requirements process IDA designed for DoD. A very brief profile of requirements study results—based upon IDA's requirements process—is also provided. References to more technical documents prepared under this IDA project are also given.

A. INTRODUCTION

For several years, IDA, and SF&RD in particular, has been studying U.S. requirements for strategic and critical non-fuel materials in the context of the National Defense Stockpile, the NDS. Today, we would like to tell you about our specific project. Joining me to offer highlights of their work on the NDS—Sean Barnett, Elly Schwartz, and An-Jen Tai.

B. WHAT IS THE NDS?

What is the NDS, anyway? Well, for starters, consider that the Prudential Life Insurance Company regularly invites us to buy "a piece of the rock" (and some of you may have!). But on our behalf, the U.S. government already has bought each and every one of us our own pieces of rock. Call them, if you will, the People's Pebbles! And here, on loan from our friendly NDS outlet—Curtis Bay Depot on the South Side of Baltimore—part of my ration—three people's pebbles: Beryl, the ore for Beryllium, used in infrared systems and laser mirrors; ferromanganese, ubiquitous in steel production; and ferrochrome, an alloy in specialty steels for tanks and missiles. I'll pass them around.

Background: What is the NDS?

- Stockpile of about 50 million tons of non-fuel raw materials, from antimony to zinc
- NDS was stocked in earnest beginning in late 40's/early 50's
- Stored in about 90 locations, 35 states
- Managed by DoD since 1988
- Inventories worth about $6.5B

A pebble sounds small, diminutive—and these are small. But when you add all the individual pebbles up, it's actually one heck of a hunk. How much? Fifty million tons worth. How much is that? Assume for simplicity it's all tin, in 70 pound ingots such as they have at Curtis Bay (pigs, they call them). Lining them up—end to end—there are enough ingots to encircle the Earth—not just once or twice, but about 25 times!

Fifty million tons is a pretty big pile. Stockage really took off in the early 1950s—as I'll illustrate a little later. And these materials have been stored—more or less politically correctly—in about 35 states for many years. Managed by DoD since 1988, these pebbles now have a market value of about 6.5 billion dollars.

Some casual observers make the mistake of characterizing the NDS as consisting of worthless relics—implying a value not of 6.5 billion dollars, but closer to zero. Consider the perspective, for example, of Mark Thompson, a Baltimore Sun reporter, after he looked at the stockpile a couple of years ago. He said...

What the NDS is...depends on whom you ask: some press needling

"A look inside the Pentagon's little known National Defense Stockpile suggests that if WW III breaks out, the U.S. military will be ready to fight WW I all over again."

Among its contents are... "150 thousand tons of tannin, used in tanning cavalry saddles and knapsacks," enough to "refight the Civil War," "1.5 million pounds of quartz crystals, at the heart of antique radios, 3.3 million ounces of quinine -- an antimalarial supplanted years ago by other medicines, 22 million pounds of mica -- used in camp stoves and to insulate radio vacuum tubes and other technological artifacts."

Background

Mark Thompson *The Baltimore Sun, 21 Feb '92*

A lot of old stuff, indeed! Even now, the NDS still has most of that inventory. For example, at the end of FY95, NDS had 130K tons of tannin; 240K pounds of quartz crystal; 3.2M ounces of quinine; and 19M pounds of mica. But there also is a lot of the kinds of materials that the U.S. still uses today—day in and day out.

The U.S. does use many stockpile-type materials, e.g.:

- Beryllium
- Ferrochrome
- Ferromanganese
- Aluminum
- Cobalt
- Tin
- Titanium

Background

For instance, the U.S. uses annually about 200MT of beryllium, several hundred thousand tons each of ferrochrome and ferromanganese, 6 million MT of aluminum, and so on.[1] And the stockpile has several years of U.S. consumption worth of most of these and a number of other materials. [2]

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1 We also use about 214K MT ferrochrome; 381K MT of ferromanaganese; 6 million MT of aluminum; 7.5K MT of cobalt; 45K MT of tin; 19K MT of titanium.

2 Very roughly, two years' worth (44ST) of beryllium (plus ores and Beryllium Copper Master Alloy); 3.5 years' worth of ferrochrome; 2.5 years' worth of ferromanganese; three days' worth (63K ST) of aluminum metal; eight months' worth (16MT) of bauxite; three years' worth (23K ST) of cobalt and (134K MT) tin; and two years' worth (37K ST) of titanium.

Yet peacetime use, even widespread peacetime use, does not by itself mean the U.S. government will or should stockpile.

...But that doesn't mean the Government needs a stockpile

- U.S. uses a lot of iron, wood, cement....
- Key: prudent demand-supply comparisons for scenarios of concern

Background

The U.S. uses 75 million MT of iron—and 92 million MT of cement—per year, but the U.S. does not stockpile these, certainly not in the National Defense Stockpile and, if it does stockpile it elsewhere, not much as a percentage of annual use. And I'm really not trying to push for stockpiles of such items either.

What I am suggesting is that the government should consider stockpiling when it's not feasible (or cost effective) to get what is judged necessary or highly desirable quickly enough at the time it's needed.[3]

OK, so this is what the NDS is—a pile of rocks, an insurance policy against potential shortages. But so what? What, more specifically, is our project about anyway?

First, I'll offer a capsule summary of what we at IDA have been doing concerning the NDS. Then a bit of history concerning the evolution of the NDS. Next, some highlights of the planning process we designed. Then a summary of the analyses we've conducted using this process, a little about the impact this work has had to date and, finally, what we're up to these days and where we're heading.

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3 To determine if the government should maintain inventories of things (or personnel) as an insurance policy, demand-supply comparisons—taking careful account of the time factor—would seem to be called for.

C. OVERVIEW OF THE PROJECT

Since 1988, Congress has in fact required DoD to manage the NDS, basically because Congress became convinced that DoD would be a better steward of this stockpile—with materials of considerable value in the production of many defense systems—than had been the NSC and FEMA.

Overview -- Problem

- Congress requires DoD to manage the Government's National Defense Stockpile of some 92 non-fuel "strategic and critical" materials (strategic: potential shortages; critical: essential)
- This multibillion dollar inventory includes many materials with significant uses in defense systems, such as cobalt, platinum, titanium, germanium, and beryllium
- By law, DoD must make recommendations concerning stockpile goals for each material in the NDS and also advise Congress if other materials warrant inclusion

So since 1988, by law, DoD has been obligated to recommend goals, that is, desirable inventory levels—each year until recently, and now every other year—for materials already in the NDS, and for any others it believes should be in there. Soon afterwards IDA was asked, and we agreed, to design an evaluation process and help DoD implement it.

The objective of the task at IDA that we call NDS Assessments is shown here—to design and help implement an architecture for NDS requirements analyses, conducting the two basic types of assessments (shown here) in the process.

Project Objective

- To design and help DoD implement an interdepartmental planning and modeling architecture for estimating NDS inventory goals
- Within this framework, IDA conducts two principal types of assessments:
  - assessments amenable to the formal modeling process
  - projects addressing more esoteric materials

Overview

In its last report to Congress on this subject—in mid-1995—the Pentagon recommended another round of reductions to the formal NDS goals, new reductions totaling approximately $3B. If these are accepted, IDA's analytic and interdepartmental consensus-building process will have been integral to the reduction of overall goals from over $17B to near zero. As I will indicate later, key DoD personnel have said publicly that IDA's work in this area is contributing directly to some very sizable savings.

Findings/Issues

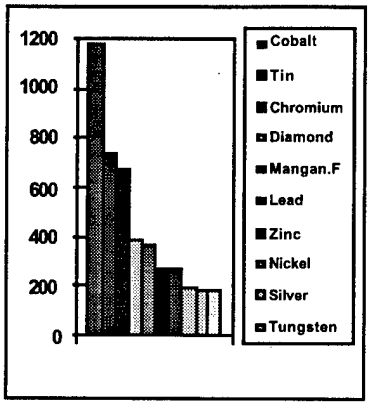
- In its 1995 Report to Congress, DoD recommends that overall stockpile inventory goals be reduced by amounts worth about $3B at current prices, down to about $25M
- Should this most recent proposal be accepted, IDA's analytic process will have been central, over the last several years, to the reduction of NDS goals from over $17B to near zero
- Overall, DoD indicates that IDA's work in this area is contributing directly to major budgetary savings, potentially exceeding $5B

Overview

But we are not resting on these laurels: there is still a lot of work left to do, not the least of which is that there is a lot of NDS inventory left to sell!

Based on its latest recommendations, here are some of the types and dollar values of materials in the NDS that DoD now deems excess and available for sale: over a billion dollars in cobalt, three quarters of a billion dollars each in tin and chromium, and several hundred million dollars for each of the other seven shown here.

Excess NDS Inventory: DoD Perspective



- Values in millions of dollars
- As of March 31, 1995
- Top 10 excess materials shown here
- Total NDS Excess: $6,536M
- Excess of Top 10: $4,467M (67%)
- Source: *1995 DoD Report to the Congress on NDS Requirements*, May 1995, p.8

Overview

Looking ahead, IDA's current and planned work in this area will focus on two main thrusts: selective model enhancements, and special studies.

Findings/Issues (2)

- With the formal modeling process well established, IDA expects to focus on selective model enhancements and special studies, such as of inventory reduction strategies that do not unduly disrupt the markets
- Anticipating significantly more sales, NDS managers at the Pentagon have recently asked IDA how best to dispose of excess inventories, beginning with DoD's multimillion dollar holdings of high purity germanium (used in a variety of applications, including Forward Looking Infra-Red devices), and natural rubber (essential for jet aircraft tires, for example)

Overview

NDS managers have recently asked IDA how to improve the disposal process, and we (especially An-Jen Tai and Sean Barnett, with able assistance from Sharon Fiore) have done several initial assessments, such as an assessment of the markets for germanium and natural rubber.

I believe it's accurate to say that market conditions for the several materials we have examined thus far look very auspicious, so our tentative recommendation to the Department with respect to rubber and germanium is—sell, sell, sell!

Findings/Issues (3)

- Initial assessments are that both markets are very strong, and that DoD should therefore press Congress aggressively for disposal authority

Overview

With this very brief overview, we'd now like to tell you a little bit about how our government got into this business, what sort of process we built, and some specifics concerning the analyses we've done and plan to do.

D. ORIGINS OF THE STOCKPILE

The first stockpile act was passed following Germany's September 1939 invasion of Poland. Known as Public Law 76-117, it formally established a stockpile as a goal. By the time of Pearl Harbor, however, only about $50M worth of materials had been bought (significantly more in today's dollars, $400M in $97, but not much compared to what the government was to buy later).

Stockpile Act of 1939

- Passed following Germany's invasion of Poland
- P.L. 76-117: Formally set U.S. Government objective of building stockpiles of key materials to ensure adequate supplies in a national security emergency
- Only $70M appropriated; only $54M bought before Dec. 7, 1941

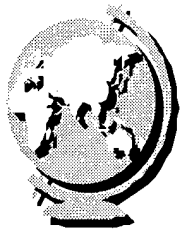
Legislation/ Planning

Then came World War II. Some of the WWII experiences are shown here—but severe rationing, priority allocation of materials to the defense effort, and collection efforts of scrap metal were all very common occurrences.

World War II

- Japanese attacks in Southeast Asia cut the U.S. off from many supplies of tin, rubber, cordage fiber
- Major import disruptions of chromium, kapok, manganese, tungsten, and antimony
- German U-boats specifically targeted bauxite barges; in 1942, 90 % of barge fleet was sunk

History



While WWII certainly featured raw material resource shortages, stockpiling in earnest really did not begin until 1950. (By the way, for those of you were wondering, kapok is a natural insulating material.)

NSC-68 and Korea

- April 1950: NSC-68, a threat assessment and a plan for a three-year military/industrial mobilization
- 25 June 1950: N. Korean invasion with Soviet support
- After NSC-68 and Korea, materials were stockpiled in large quantities:
  - 1947-48: $350M obligated by Congress
  - 1949-50: $1.1B
  - 1951: $1.5B

Legislation/ Planning

Both NSC-68 (a new U.S. threat assessment and planning scenario), and then the Korean invasion led many influential decision-makers to believe that a sizable strategic and critical materials stockpile made sense for national security purposes. And look at how much purchases accelerated in 1950-51!

Reflecting on those years later, in 1963 Ike had this to say about stockpiling strategic and critical materials.

WW II/ Korea

"You will recall that, when we became involved in WW II, our lack of an adequate stockpile of strategic and critical materials gravely impeded our military operations. We were therefore forced into costly and disruptive expansion programs. The nation was compelled to divert, at a most critical time, scarce equipment and machinery and manpower to obtain the necessary materials. However, the need for such a program was recognized, and a theoretical objective established on a predicted five-year war....After we became involved in hostilities in Korea, we went through experiences almost identical with those of WW II -- only then did realistic stockpiling begin."

-- Dwight D. Eisenhower

Truman and Ike both favored a large stockpile in principle, and in practice beginning in 1950. This lasted until the late 1950s when reliance on nuclear deterrence regained popularity—rather than a reliance on extended conventional war planning (*a la* NSC-68). A short nuclear war planning scenario—with the associated notion that such a war doesn't require much of a material stockpile, or an industrial mobilization capability for that matter—drove strategic and critical materials stockpile planning and inventory reductions through the 1960s and into the mid-1970s. By 1975, however, the House Armed Services Committee took vigorous action to block what it saw as an unwarranted sell off by the Nixon White House.

Stockpile Planning

- Late 40's-50's: Truman and Eisenhower support strong stockpiles; reductions in late 50's (goals lowered in '58 from five to three years)
- 60's: Kennedy and Johnson pare goals and inventories significantly (sales 1964-'68: $2.3B)
- 1973: Nixon declares one-year emergency stockpile sufficient (sales in 1974: $2B)
- 1975: House Armed Services Committee rejects one-year concept, requires three years

Legislation/ Planning

After Watergate and Nixon's resignation, President Ford went along with Congress in this area. Then, in 1978, political instability in Zaire disrupted supplies of cobalt and led to a quick quadrupling of cobalt prices. By 1979, advocates of a large stockpile had persuaded Congress to limit executive branch disposal authority. In that same year, Congress took significant steps to reassert control: it established the NDS Transaction Fund to keep closer track of what the Executive branch was doing with the NDS; placed tight limits on Executive branch strategic and critical materials disposals; and encouraged analyses of requirements that established very robust goals, in particular the FEMA analyses of 1980 that led to codification in law of goals on the order of $20B.

Stockpile Planning

- Mid-70's: Ford endorses three-year stockpile concepts, goals
- 1979: Congress passes P.L. 96-41; restricts sales
- 1980: Carter affirms three-year targets; increases goals to over $20B based on FEMA study
- 1981: Reagan begins first significant stockpile purchases in 20 years--cobalt, bauxite, etc.
- 1985: After NSC study Reagan reverses position, says most NDS inventories unnecessary

Legislation/ Planning

With the election of Ronald Reagan, his administration started to make good on a campaign pledge to buy key materials for the stockpile that were short of the new goals—beginning with the material that had been most affected by the trouble in Zaire—cobalt. Just before this, soon-to-be Secretary of State Alexander Haig had set the tone by declaring, on 10/18/80: "Should future trends, especially in Southern Africa, result in alignment with Moscow of this critical resource area, then the USSR would control as much as 90 percent of several key minerals, the loss of which could bring the severest consequences to the existing economic and security framework of the free world."

Soon thereafter, the Reagan administration went further—commissioning a major new NSC-led study of NDS requirements. When the study was completed, however, it resulted in a startling turnabout: the Reagan administration declared that most NDS inventories were unnecessary.

So dramatic was the turnabout that this study represented, and so rife with dissent were some of the various NSC study work groups, that when the GAO finished the review of the NSC study that it had been ordered by the Congress to prepare, it was pretty easy for the Chairman of the HASC subcommittee to dismiss the study.

Stockpile Planning

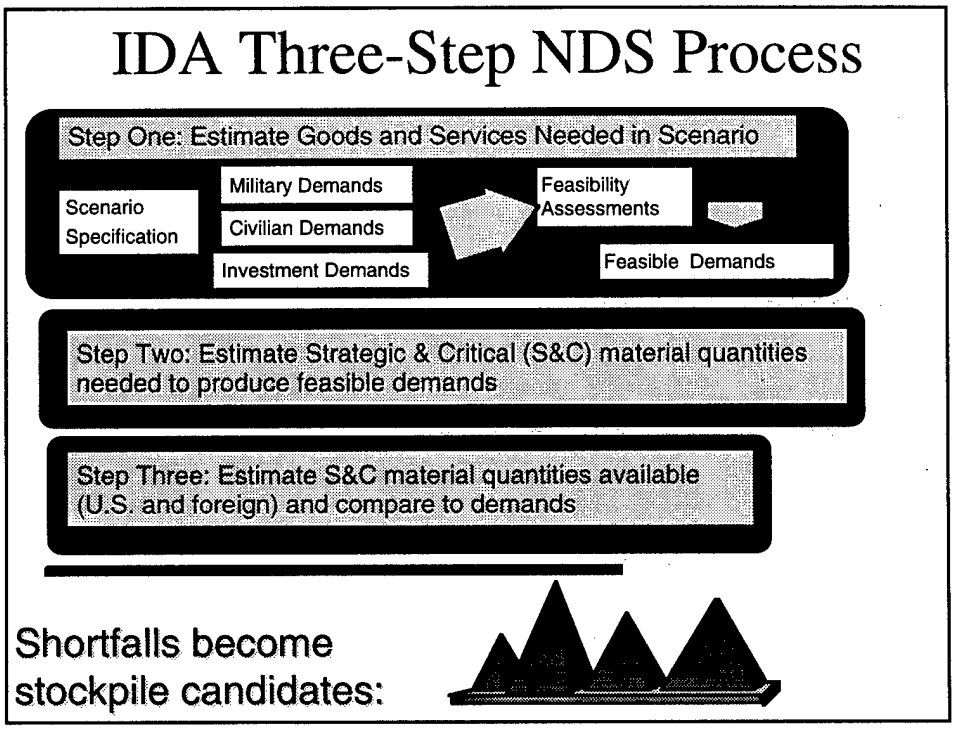
- 1987: GAO completes review of Reagan's NSC study of NDS, declaring it inadequate
- Dec. 1987: Congress directs DoD to take over NDS requirements assessments and management, requires total mobilization scenario
- June 1988: DoD asks IDA to assess military requirements for NDS materials
- Fall 1988: IDA designs initial process for NDS requirements assessments

Legislation / Planning

In December 1987, Congress directed DoD to take over the NDS, including requirements assessments. Six months later, DoD asked for IDA's help. And six months after that, after quite a few very long days and nights, we had designed and assembled the first working version of the process we use today.

E. IDA'S NDS PLANNING PROCESS

Here is an overview of the process. Step One: within the specified scenario, assess demands for critical outputs from each sector of the economy, and assess what it is feasible to produce of those demands (within given time and factor-of-production constraints); Step Two: estimate the strategic and critical materials needed to produce these demands; and Step Three: compare the strategic and critical materials demands with S&CM supplies projected to be available (domestic and foreign). Any shortages become NDS stockpile candidates.



A little detail on each substep in Step One is shown here. A Congressionally mandated scenario has been used so far—a multi-year, "big war," "reconstitution-type" scenario, featuring a significant mobilization period, an initial conflict, and then regeneration of forces for a second, decisive, successful conflict. Civilian "essential" demands are then determined by a civil sector workgroup representing all interested Departments and Agencies (Commerce, HHS, Agriculture, Treasury, FEMA, State, etc.).

NDS Planning: Step One

- Scenario Specification
  - Congressionally mandated
  - Joint Staff adds details
- Military Demands for Goods & Services
  - Extra Force Structure
  - Consumption
  - Attrition replacement
- Civilian Demands for Goods & Services
  - Baseline economic projection
  - Modify based on advice from civil sector group
- Additional Investment Requirements
- Feasibility Assessments

IDA Planning Process

We also estimate any additional necessary and feasible plant construction, using a special algorithm developed here at IDA by Drs. Tai and White. And we conduct feasibility assessments—how much of the extra military demand can be built within the time frames of the scenario. The result of this step, then, is a set of time-phased demands for output judged to be both necessary and producible, from each major sector of the economy (expressed in total demand terms), for each year of the scenario, tracked by whether the demands are derived from the military or the civilian requirements, for each of 241 sectors of the economy.

Step Two then uses these demands to compute the strategic and critical materials demands associated with producing the industrial outputs estimated in Step One.

NDS Planning: Step Two

- Compile feasible demands for output from individual industries derived from Step 1, by period and tier (civilian, military, investment)
- Determine average material input requirements (MCRs) for each industry to produce a given amount of output
- Estimate total material inputs required across all industries to produce scenario Goods and Services, by period and tier

IDA Planning Process

To offer a little detail on this step, for which he has been principally responsible in recent years, here is An Jen Tai.

From Step One: Industry Level Requirements Generation

- Civilian and Base Military Demands
  LIFT/ILIAD
- Emergency Military Demands
  DEIMS Translator
- Investment Demands
  FORCEMOB

Industry-level requirements can be divided into three groups. The Civilian and Base Military Demands are benchmarked to the administration's economic scenario produced by the Council of Economic Advisors. We then use INFORUM's LIFT/ILIAD models to compute a set of inter-industry forecasts consistent with that scenario. In addition, we take into account other assumptions reached by an inter-agency working group on the availability of supplies for civilian consumption and exports. Emergency military demands are computed using the DEIMS translator developed by PA&E. The DEIMS translator converts projected expenditures on specific weapon systems, munitions, other consumables, etc., into demands on industries. Once that is completed, FORCEMOB integrates all of the above and determines whether the existing infrastructure can support them. If not, FORCEMOB computes the amount of additional investment in capital necessary to meet any unmet demands, and estimates the feasibility of producing these items on a timely basis using new capital.

Step Two: Materials Requirements Generation

- Material Consumption Ratios (MCR)
  - Historical Consumption Analysis
    - Source: Commerce Dept.
  - Historical Industry Output Series
    - Source: INFORUM
- Estimate Consumption = MCR x Output
- Sum over all industries by period by tier

Through the first step, we have now computed, industry by industry, the output requirements on the economy from our conflict scenario. To complete the process, we utilize a set of materials consumption ratios, or MCRs. The MCRs are constructed using sector by sector materials consumption distributions—supplied by analysts at the Department of Commerce—and historical output data from INFORUM. For each material, an MCR is an estimate of how much a given industry consumes per dollar worth of output (normalized to 1987$). Multiplying an MCR by the output for the corresponding industry gives us an estimate of the quantity that industry will use. Summing over all industries gives us an estimate of the quantity demanded in the scenario, by period and by tier.

Step Three then compares the time-phased demands for these materials with projected material supplies for the scenario, and estimates any projected shortfalls.

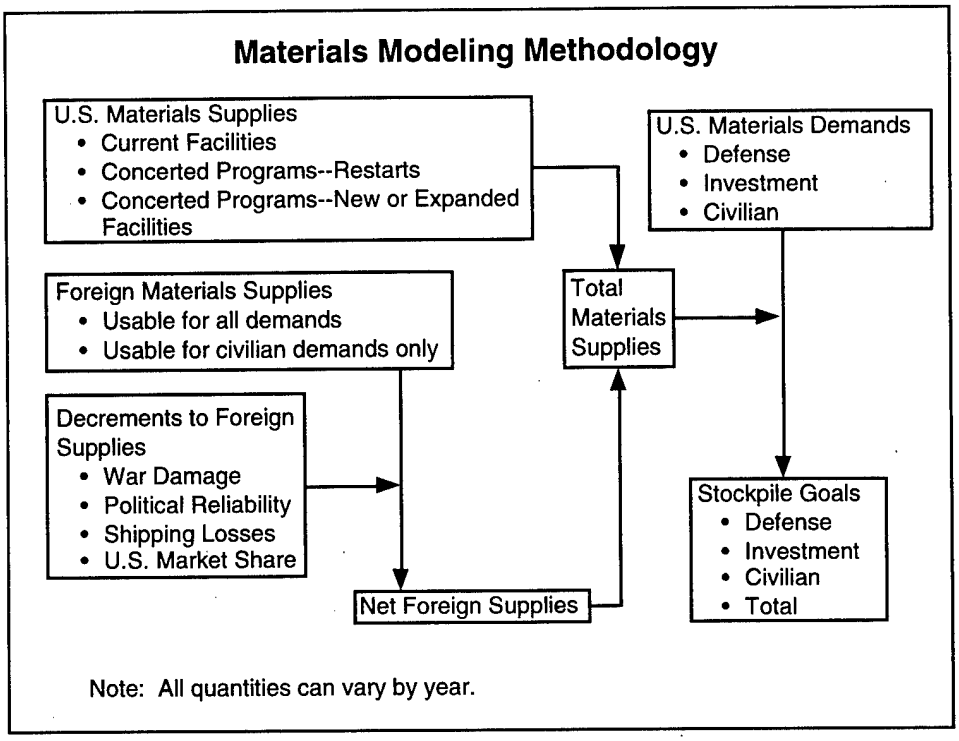
The device we have developed over a number of years to integrate all these supply and demand estimates in Step Three is labeled the Stockpile Sizing Module, or the SSM.

NDS Planning: Step Three

- Assess material supplies projected to be available in the scenario, by period and tier (domestic production plus foreign)
- Compare supplies against projected demands in the scenario, by period and tier, with period surpluses usable later
- Sum projected shortfalls across all periods, each tier, each material

IDA Planning Process

Using a flow chart to depict the structure of the SSM, Elly Schwartz will now show its principal components.



Information on projected mineral supply capacity (U.S. and foreign, by country and year) is obtained from commodity specialists at the U.S. Geological Survey.

For U.S. supplies, we estimate U.S. production capacity in current facilities and also with "concerted programs." Additional materials, now not economic to produce, could be produced in the U.S. if the U.S. government paid some or all of the production costs or promised to buy specified amounts of material at an agreed-upon price. Concerted programs include dormant mines that could be reopened and proven reserves of minerals that could be mined. Stockpile Sizing Module results are reported for both cases, with and without the consideration of concerted programs.

Foreign supplies can be affected in this scenario by several factors. For each country in each year of the scenario, war damage, political unreliability (values obtained from the State Department), and shipping losses (values obtained from the JCS) may reduce the amount of material the U.S. could obtain. A U.S. market share factor, which can vary by material and year, also is applied to the foreign supply.

The model compares scenario demands with U.S. and net foreign supplies. Demands occurring early in the scenario cannot be satisfied by later supply excesses, but a supply excess in a given year can be "stored" and used to offset demands occurring later on in the scenario. Demands that remain unsatisfied become suggested National Defense Stockpile goals.

The model can distinguish between foreign supply that can be used to satisfy civilian demand only, and foreign supply that can be used to satisfy any tier of demand (civilian, defense, or investment). This distinction can lead to unsatisfied defense (and/or investment) demands, even if overall supply capacity exceeds overall demand. Factors influencing this categorization include supplier country, year of scenario, and a country's percentage of the world supply. The model contains a number of inputs that can be varied to expeditiously conduct sensitivity analyses on these factors.

The Stockpile Sizing Module computations are implemented in an interactive, Windows-based, mouse-driven computer program written in a combination of Excel macro language, C, and Windows programming language.

F. CASE STUDIES

This, then, is an overview of the three-step modeling process we use. On a parallel track with the modeled assessments are a series of case studies. Over the last several years, case studies have been conducted of 14 materials.

Material Case Studies

- 14 candidate materials nominated by OSD
- Mostly metals used in small amounts or specific applications; large-scale modeling approach not applicable
- Case study approach
  - Supply Estimates
  - Demand Estimates
  - Stockpile Recommendations
- Detailed case studies performed per OSD requests
  - Germanium
  - Depleted Uranium
  - Jewel Bearings
  - Beryllium

OSD nominated the 14 candidate advanced materials to be analyzed for potential inclusion in the NDS. Most of the materials are metals. We analyze them "off line" because they are not suitable for modeling via our large-scale process. The advanced materials often are used in extremely specialized applications and in small amounts, unlike the on-line materials that are used widely throughout the economy. Also unlike on-line materials, some advanced materials are used primarily in military systems.

We use the case study approach to estimate advanced material stockpile requirements: we estimate the supply of the materials from foreign and domestic sources; the requirements for civilian and military applications (demand) during the NDS scenario; and we recommend inclusion in the stockpile on the basis of the supply and demand balance.

At the request of OSD, we also have conducted comprehensive, detailed case studies for advanced materials; over the past six years, IDA has completed extensive case study work on germanium, depleted uranium, jewel bearings, and beryllium. For germanium, IDA also has analyzed the market for the material to help OSD dispose of it most economically.

The graphic shows the advanced materials and their largest applications. Most of the materials' applications are civilian, but some are predominantly military.

Advanced Material Applications

Material	Applications
Aerospace Rayon Fiber	Rocket nozzle insulation in missiles and spacecraft
Beryllium	Beryllium metal: aerospace applications Beryllium copper: computers, electrical connectors, telecommunications Beryllium oxide: high temperature electronics
Boron	Boron: insulation, fiberglass, soaps, detergent. Boron carbide and nitride: abrasives and cutting tools. Boron composites: military aircraft
Gallium	Gallium arsenide semiconductors
Germanium	Lenses of infrared sensors, semiconductors, fiber optics
Hafnium	Superalloys, nuclear reactor control rods, refractories
Indium	Solders and alloys, electrically conductive glass coatings, semiconductors
Rhenium	Jet engines, gasoline production catalysts
Rhodium	Automobile catalytic converters, electronics, chemical catalysts
Ruthenium	Integrated circuits, chlorine recovering anodes
Tellurium	Metallurgy, rubber production, electronics, infrared detectors
Depleted Uranium	Armor piercing shell penetrators, tank armor, nuclear weapons
Yttrium	Red light phosphors, ceramics, garnets for lasers and microwave circuit elements, alloys
Zirconium	Refractories for steel and glass making, abrasives, special metal casting, nuclear reactor fuel rods

G. INITIAL IDA ANALYSES

IDA conducted four overall NDS requirements analyses between 1989 and 1991, and the goals estimated in these analyses were all well below the goals that had been placed on the books in the early 1980s by the Congress, based upon the 1980 FEMA study.

IDA Assessments: 1989-1991 NDS Requirements

- DoD provided NDS assessments to Congress, based on IDA three-step process
  - Lower for almost all materials than goals on the books from late '70s through early '80s
- DoD did not formally recommend implementation of new goals, however.

For one reason or another, however, the Department did not formally recommend changes in these goals.

H. THE 1992 REPORT

Then, in 1992, the situation changed.

1992 NDS Requirements Assessments

- SecDef (Cheney) recommended new goals to Congress, sweeping reductions
- ~$3B estimated market value (~1/5 of goals then on books)
  - less robust "essential civilian" demand
  - military able to use Caribbean sources

IDA Analyses

Secretary Cheney explicitly endorsed the assessments we had prepared and submitted them as formal recommendations to Congress. Based on these assessments, huge reductions in existing goals were proposed. Changes in two major factors (compared to those in the FEMA 1980 study) drove those reductions: the 1980 study had declared as "essential" civil sector demands that were basically peacetime levels—in the context of a global war—i.e., basically no belt-tightening; and the 1980 study had also posited that virtually no foreign sources of strategic and critical materials would be available to the U.S. for the duration of the multi-year planning scenario. The 1992 DoD study, by contrast, assumed some belt-tightening (agreed upon by the civil sector workgroup), and made more permissive assumptions concerning the availability of foreign supply, such as the assumption shown here.

The reaction to these recommendations from the Hill, especially from the House Armed Services' Committee oversight committee, was not surprising. The Chairman scheduled hearings and called for a GAO review. IDA cooperated fully with the GAO, and GAO concluded that the process was sound but that the MCR data base was too old to rely on, and that it should be updated before the Hill accepted the recommendations. We in fact had been urging PA&E (the initial sponsor for the MCRs) to update this data base for several years, and we were allowed to do so after the GAO finding when another DoD sponsor took over responsibility for MCR maintenance.

The update has been completed in stages, under An-Jen Tai's leadership. Some MCRs were updated by the time the 1993 Report to Congress was due. The 1993 Report also included some additional changes from the 1992 assumptions. Because the MCR update was not complete, however, the 1993 goal recommendations were declared by DoD to be interim.

The 1993 requirements estimates were lower—by almost an order of magnitude—than those from 1992. However, this change was not attributable to the new MCRs, but rather to the three types of changes shown here (relative to 1992): a smaller force requirement, reflecting changes in even the reconstitutable capacity of our principal potential adversary; a willingness within DoD to let the military rely, in the stockpile planning scenario, upon more foreign sources of strategic and critical materials than they had been permitted to in preparing the 1992 report [details are classified.]; and a longer mobilization period, the principal effect of which was to provide more time for the U.S. to buy foreign supplies on the open market—before the far more restrictive foreign supply assumptions of the war period in the scenario were said to set in.

1993 NDS Requirements Assessments

- DoD recommended new, interim goals
- ~$0.4B (~1/50th of goals on books)
  - smaller extra military requirement
  - military able to use more sources in mobilization
  - longer mobilization period

IDA Analyses

I. NEW GOALS

With these two reports in hand, and given related congressional actions to grant DoD additional disposal authority for many materials (to levels well below goals then on the books), DoD counsel determined that NDS goals had been lowered in many cases to levels near those DoD had recommended in the 1992 Report to Congress. The practical effect was that significant extra quantities of material inventories could now be targeted by DoD for sale.

New NDS Goals

- New NDS Goals -- following recommendations from DoD's 1992 Report to Congress, new, lower NDS goals take effect after Congressional action to approve disposals.

J. IMPACT

On the strength of these changes in public policy, by late 1993 DoD had some very nice things to say about our work.

Impact of IDA NDS Analyses

"The analyses IDA has supported have reduced stockpile requirements by $15B dollars and led to disposals of excess NDS inventories which will eventually generate $5 to $6 billion in revenue to DoD."

--Dr. Paul Halpern
Director of Industrial Programs
The Pentagon

As we have mentioned, there have been two major parts to the analytic process: the modeling effort, and the case studies. Sean Barnett has generally led the case study efforts in recent years, and following are some highlights he has compiled of both the findings and the impact of those research efforts.

Detailed Case Studies and Impact

- **Germanium**: OSD will sell the 68-ton germanium stockpile for about $92 million; IDA has assessed the germanium market to minimize the disruption the sale might cause and to maximize Government profit
- **Depleted Uranium**: OSD successfully reversed legislation requiring the purchase of $180 million worth of depleted uranium for which there is no stockpile requirement
- **Jewel Bearings**: OSD will sell the jewel bearing stockpile and the government-owned jewel bearing plant, saving about $2 million/year.
- **Beryllium**: OSD seeks authority to sell some forms of beryllium now and has recommended to Congress that the NDS goal for beryllium be dropped to zero.

IDA's large, detailed case studies have had a significant impact on OSD's decisions to include, exclude, or dispose of materials in or from the stockpile.

In 1990, IDA conducted a detailed analysis of the production cycle for germanium and its applications, especially its use in the lenses of night vision devices. Subsequent analyses have shown that there is no need to keep germanium in the stockpile, and OSD has decided to dispose of the material. IDA assessed the germanium market last year and found that OSD could sell the 68-ton stockpile for about $92 million. We recommended selling the material immediately, to take advantage what appeared to be a temporary bubble in the market price, and thus maximize OSD's return.

In 1991, IDA assessed stockpile requirements for depleted uranium at the request of OSD, in response to a new law requiring stockpile managers to acquire $180 million worth of the material. IDA found that while the military, particularly the Army and the Air Force, used significant quantities of depleted uranium (DU), the domestic supply of the material was very large compared to projected requirements, and thus there was no need for a stockpile. IDA's analysis was instrumental to OSD's efforts to persuade Congress that DU was not needed in the NDS.

In 1993, IDA assessed stockpile requirements for jewel bearings. Jewel bearings are small, finely machined pieces of synthetic sapphire used in analog instruments. The United States experienced shortages of these bearings in World War I, World War II, and the Korean War because it could not obtain sufficient quantities from Switzerland, where most were produced. In response to the shortages, in 1953 the government built the William Langer Jewel Bearing Plant in Rolla, North Dakota, to supply bearings for the military in wartime. The government used the NDS to subsidize operations of the plant in peacetime for about $2 million per year.

Because of growth in technology—the switch from analog to digital instruments—the demand for jewel bearings dropped by a factor of 10 from 1970 to 1990. Because of the presence of alternative jewel bearing suppliers in Western Europe, and changes in the European military and political situation, the wartime supply likely to be available to the United States is much larger than in the past. IDA's assessment conclusively demonstrated the absence of a stockpile requirement, and OSD used our analyses to finally secure approval of the sale of the Langer plant and liquidation of the jewel bearing stockpile.

In 1994, IDA completed its assessment of the stockpile requirements for beryllium. A U.S. company is the world's leading producer of beryllium, and during the assessment an IDA analyst visited its production plants and discussed beryllium production extensively with plant and company officials. The IDA study helped highlight the kinds of factors that affect the reliability of a sole source U.S. producer. In 1995, largely on the basis of the study, DoD recommended to Congress that the beryllium goals be dropped to zero.

K. 1995 NDS REQUIREMENTS ASSESSMENTS

In mid-1995, IDA completed the last report that DoD has submitted to Congress on this subject. In it, the Department recommended new and even lower NDS requirements. Two key factors led to these new, lower goals: first, the administration decided that, in the context of the new NDS planning scenario, it was not critical to guarantee the availability of the Platinum Group Metals—the PGMs of the strategic and critical materials world—for new civilian auto parts. And second, foreign sources of supply were assumed to be available at normal, business-as-usual levels until a war actually begins.

1995 NDS Requirements Assessments

- DoD recommended new, lower NDS requirements
- Estimated ~$25M (~1/500th of goals on books when IDA began the project)
  - PGMs for auto parts not guaranteed
  - no reliability decrements until war

IDA Analyses

L. 1997 NDS REQUIREMENTS STUDIES

Since the 1995 Report, the IDA study team effort has focused on documenting the recent assessments and model enhancements, and preparing several new studies. We currently are concluding a major phase of data preparation for the 1997 report to Congress, due in January 1997. This report will actually have two major tracks, shown here.

1997 NDS Requirements Studies

- One track of analysis based on current, big-war, mobilization scenario
- A second track of analysis based on regeneration-type scenario following a 2 "nearly simultaneous" MRC case

IDA Analyses

The first track will follow scenario and planning factors—as in prior versions.

As for the second track, a number of things are still to be determined. We hope to be able to get DoD to develop some more defense-specific MCRs and production capability assessments with existing contractors. There is interest in this. We also hope to begin building data bases for analyses that combine information about specific prime vendors with more generic capability information about the lower tiers.

Other analyses we are pursuing follow from the fact that now that most of the National Defense Stockpile is excess, and there is a lot to dispose of. We expect to work with DoD to seek ways to dispose of this stockpile as aggressively as possible—without unduly disrupting the markets.

Other IDA NDS Analyses

- Market analyses
  - germanium
  - rubber
  - other
- Inventory disposal options
  - market impact assessments
  - futures options

IDA Analyses

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Since June of 1988, the Institute for Defense Analyses has been assisting the Department of Defense in developing a systematic process to estimate U.S. stockpile requirements for strategic and critical materials. This annotated briefing provides a capsule history of the National Defense Stockpile of strategic and critical non–fuel materials, a review of requirements planning studies prior to IDA's involvement, and a summary of the NDS requirements process IDA designed for DoD. A very brief profile of requirements study results—based upon IDA's requirements process—is also provided. References to more technical documents prepared under this IDA project are also given.

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