

July 1994

MILITARY AIRLIFT

Comparison of C-5 and C-17 Airfield Availability





United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-257746

July 11, 1994

The Honorable Sam Nunn
Chairman, Committee on Armed
Services
United States Senate

The Honorable Strom Thurmond
Ranking Minority Member
Committee on Armed Services
United States Senate

The Honorable Ronald V. Dellums
Chairman, Committee on Armed
Services
House of Representatives

The Honorable Floyd Spence
Ranking Minority Member
Committee on Armed Services
House of Representatives

The fiscal year 1994 conference report on the Department of Defense's (DOD) Authorization Act requires that we monitor the cost, schedule, and performance of the C-17 program and report to the House and Senate Committees on Armed Services. Since the Air Force considers the C-17's ability to land at substantially more airfields than the C-5 crucial, we are providing our analysis of the number of airfields that will be available to the C-17 compared to what is available to the C-5.

Results in Brief

The Air Force has reported that based on wartime runway length and width requirements, the C-17's capability to land on short airfields would enable it to land at about 9,900 airfields in the free world (less the United States) compared to 3,500 for the C-5. However, this estimate did not take into account runway strength and included all types of airfields, ranging from concrete and asphalt to gravel, dirt, and grass, many of which are not suitable for either aircraft. When wartime landing requirements, including minimum runway strength, are considered, the C-17's wartime airfield advantage decreases from 6,400 to about 900 airfields.¹

¹The 6,400 figure excluded airfields in the United States. The 900 figure excluded airfields in North America. However, the effect is minimal.

The C-17 advantage is further reduced when only airfields that have been determined by the Air Force to be suitable for military operations are considered. To date, the Air Force has surveyed about 2,800 airfields worldwide as suitable for military operations. When wartime landing requirements, including minimum runway strength, are considered, the C-17's wartime airfield advantage is 145. When airfields in the United States, Canada, and Mexico are excluded, the C-17's wartime advantage decreases to 95 airfields.

Although DOD and the Air Force have claimed that the C-17's capability to land at small, austere airfields during contingencies provides significant military advantage, DOD's 1992 Mobility Requirements Study identified only three such airfields that would be used by the C-17 in the major regional contingency scenarios. Two are located in Korea and one in Saudi Arabia.

In discussing the issues raised in this report, Air Force officials stated that the number of airfields that will be available to the C-17, but are not available to the C-5, is not as great as previously reported. Further, these officials stated that the Mobility Requirements Study is based on current military doctrine that does not reflect the use of small, austere airfields and that when the C-17 is fully operational, the Army will change its doctrine accordingly. Army officials told us they will not begin to plan for the aircraft's capability until it is fully operational. Air Force officials also told us the Mobility Requirements Study did not reflect the use of small, austere airfields since this capability is not a major factor in the southwest Asia or Korean scenarios.

Comparison of C-17 and C-5 Airfield Availability

Over the years, there has been considerable debate concerning the number of airfields on which the C-5 and the C-17 can land. The C-17 Operational Requirements Document specifies a wartime landing performance capability of landing on a 3,000-foot long by 90-foot wide paved runway. According to an Air Force official, all C-17 pilots will be trained for the wartime performance landing capability. Normal landing performance is defined as safe and routine landings on a paved runway 4,000 feet long by 90 feet wide.

The Air Force restricts the C-5 to runways 5,000 feet long by 90 feet wide during wartime. However, Air Force officials believe this criteria is unrealistic since C-5 pilots are not trained to land on runways smaller than 5,000 feet long and 150 feet wide. They said that 131 feet is the narrowest runway the C-5 has landed on during wartime. Normal landing

performance is defined as landing on a paved runway 6,000 feet long by 147 feet wide.

In 1986² and 1991,³ the Air Force reported that the C-17 would be able to land on three times as many airfields as the C-5, or 9,900 compared to 3,500 for the C-5, a 6,400-airfield advantage for the C-17. These estimates were using wartime landing requirements where the C-17 would land on runways at least 3,000 by 90 feet and the C-5 would land on runways at least 5,000 by 90 feet. However, these estimates did not consider runway strength and included all types of runways ranging from concrete and asphalt to gravel, dirt, and grass, many of which are not suitable for either airplane.

Runway Strength Affects Airfield Suitability

Whether an aircraft can land on an airfield depends upon a number of factors, including runway length, width, and strength or load classification number (LCN). LCN is a number ranging from 1 to 120 and represents the strength of the runway.⁴ The higher an LCN, the stronger the runway. Aircraft also have designated LCNS. Aircraft with higher LCNS should land on stronger runways. The C-17 is more limited in this respect than the C-5. The C-17's LCN is 48, whereas the C-5's LCN is 32.

The Defense Mapping Agency classifies LCNS into broad categories called load classification groups (LCG). An LCG of I includes LCNS from 101 to 120. An LCG of II includes LCNS from 76 to 100. At maximum payload, both the C-17 and the C-5 fall into LCG IV, which includes LCNS from 31 to 50. According to Defense Mapping Agency officials, a C-17 or C-5 could make unlimited landings on an LCG IV-type runway and should not damage the airfield.

It is not clear whether LCN or LCG should be used to determine aircraft landing requirements. The C-17 contract requires the aircraft to land on paved runways with an LCN of 48. However, the C-17 Operational Requirements Document calls for it to land on runways rated as LCG IV. When LCG IV criteria is used to determine airfield suitability, the number of airfields that the C-17 can land at increases because weaker runways, those with LCNS ranging from 31 to 47, also become available.

²The Case for the C-17: the Operators's View (1986).

³Airlift and U.S. National Security: the Case for the C-17 (1991).

⁴LCN quantifies the relative strain placed on a runway by different types of aircraft operating at different weights and tire pressures and with differing number of wheels.

According to Air Force officials, LCN is a peacetime design criteria, and wartime airfield access is not based on peacetime criteria. We were told that an LCN of 20 should be used when assessing airfields for use during wartime. Based on this criteria, a C-17 or C-5 could land on a runway with an LCN of 20 about 100 times before severely damaging it.

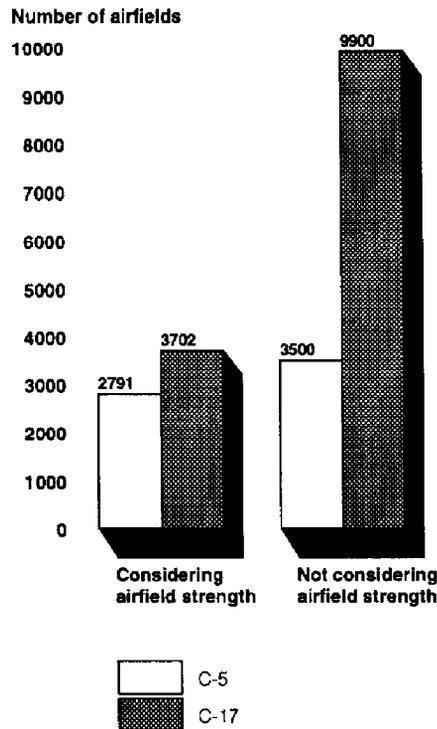
Comparison of Airfield Access

Using recent Defense Mapping Agency data and excluding airfields in the United States, Canada, Mexico, and Central America,⁵ we compared airfield availability worldwide for the C-17 and C-5 based on wartime landing requirements, including runway strength.

When an LCN of 20 is used as criteria for runway strength, the C-17's airfield advantage decreases significantly. As shown in figure 1, according to Defense Mapping Agency data, the C-17 can land at 3,702 airfields compared to 2,791 for the C-5. According to the Air Force's reported numbers, the C-17 can land at 9,900 airfields and the C-5 at 3,500. Thus, the C-17's airfield advantage decreases from 6,400 to 911 under wartime conditions. While this represents the number of potentially suitable airfields, before actually using one of these airfields, other factors such as runway obstructions would have to be taken into account. As a result, the actual number of airfields accessible to either aircraft is probably somewhat less than shown in figure 1.

⁵The Defense Mapping Agency identified airfields by continent. As such, airfields within Central America are included in the North America totals and cannot be separately identified.

Figure 1: Impact of Runway Strength on Airfields Available to C-17 and C-5



Note: The C-5's wartime criteria is 5,000 by 90 feet, and the C-17's wartime criteria is 3,000 by 90 feet.

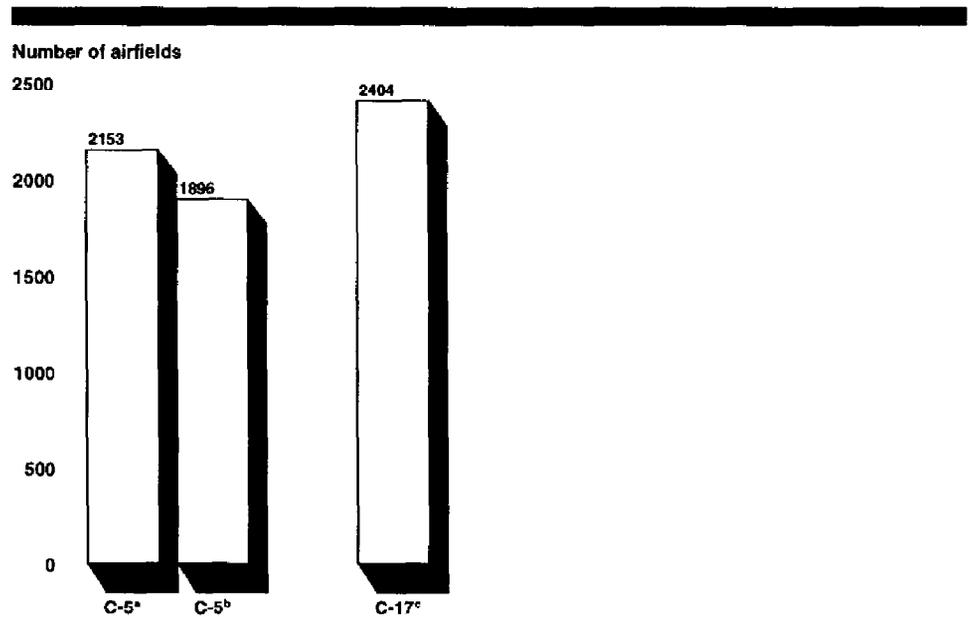
Using a runway width of 131 feet, the width that Air Force officials have told us is the narrowest runway that the C-5 has actually landed on during wartime, results in a C-17 advantage of about 1,400 airfields.

Airfield Availability Based on Operational Requirements

The C-17's airfield advantage is also less than previously reported when runway availability is based on LCG and type of surface. According to the C-17 Operational Requirements Document, the C-17 must be able to land on a paved airfield 3,000 feet long by 90 feet wide with an LCG I-IV. Using this criteria, the C-17 could land at 2,404 airfields. The C-5 landing with the similar criteria could land at 2,153 airfields 5,000 by 90 feet wide and 1,896 airfields 5,000 by 131 feet wide. The C-17, therefore, has only a 251-airfield advantage worldwide when the published runway criteria is used and a

508-advantage when the Air Force modified criteria is used. Figure 2 compares C-17 and C-5 airfield availability based on wartime landing requirements using allowable LCGs.

Figure 2: Airfields Available to C-17 and C-5 (LCG I-IV)



^aC-5: 5,000 x 90 feet
^bC-5: 5,000 x 131 feet
^cC-17: 3,000 x 90 feet

Fewer Airfields Determined Suitable for Military Missions

The number of airfields surveyed by the Air Mobility Command and identified as suitable for military airlift is about 7,100 less than the approximately 9,900 airfields identified by Air Force using Defense Mapping Agency data. The Airfield Suitability Report, prepared by the Air Mobility Command, lists 2,783 airfields worldwide that have been analyzed to date for their suitability for military operations. Besides runway length and width, the Air Mobility Command assesses airfield suitability for each airlift aircraft based on runway strength, entry and exit, taxiways, parking, and obstructions.

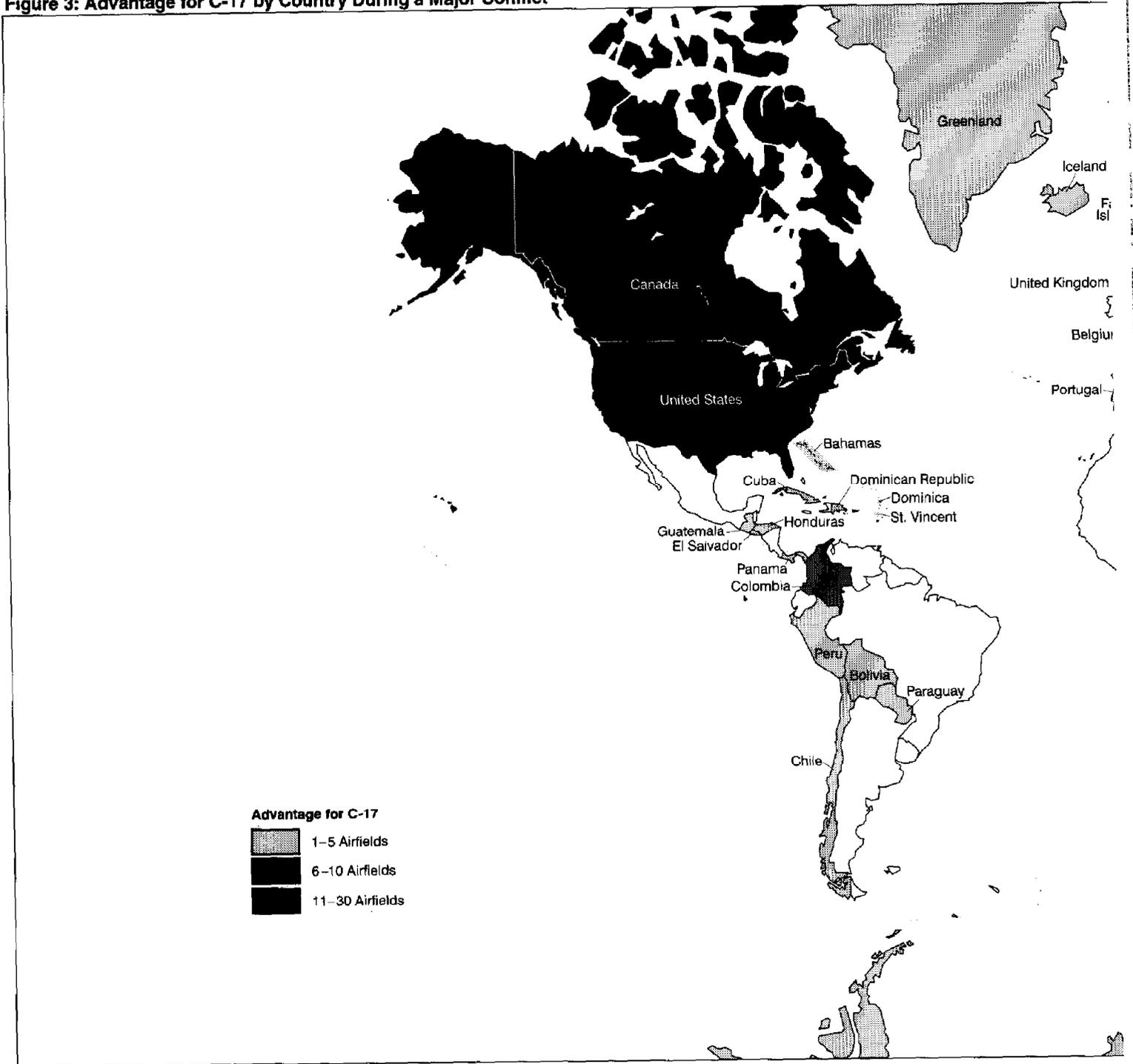
Airfield Availability Based on Airfield Suitability

Our analysis of the Airfield Suitability Report data using wartime landing requirements shows that the C-17 has little or no airfield advantage in many countries. Figure 3 shows that the C-17's airfield advantage over the C-5 is greatest in the United States, Canada, Japan, Colombia, and Germany. In Korea, the C-17's airfield advantage is six and in Saudi Arabia the advantage is limited to one airfield. In total, the C-17's airfield advantage over the C-5 amounts to 145. When airfields in the United States, Canada, and Mexico are excluded, the C-17's airfield advantage over the C-5 is 95 airfields.

We found that 830 of the 2,783 airfields in the Airfield Suitability Report are in countries where the C-17 had no advantage. That is, both the C-5 and C-17 could land at an equivalent number of airfields. Further, we identified 585 and 440 of the 2,783 airfields that did not meet C-5 and C-17 wartime landing requirements, respectively. Appendix I provides a listing of those countries where the C-17 has an airfield advantage.

Air Force officials told us that the Airfield Suitability Report is a conservative estimate of airfields available to the C-17. They stated that airfields are only surveyed for suitability upon request; thus, when the C-17 becomes fully operational, the number of suitable airfields may increase.

Figure 3: Advantage for C-17 by Country During a Major Conflict





Few Austere Airfields in the Mobility Requirements Study

Although the ability to land at small, austere airfields is claimed by DOD and the Air Force as a major advantage for the C-17, few austere airfields worldwide are likely to be used in the major regional contingencies for which DOD is planning. DOD's 1992 Mobility Requirements Study emphasized regional contingencies and highlighted the southwest Asia and Korean scenarios as demanding scenarios for planning airlift needs.

For the Mobility Requirements Study, the Joint Chiefs of Staff asked the Air Mobility Command to investigate the impact of C-17 direct delivery in the major regional contingency scenarios. The Air Mobility Command identified only three small, austere airfields in the two theaters that would likely be used in the deployments. Two airfields are located in Korea and one is in Saudi Arabia.

In discussing the issues in this report, Air Force officials stated that the Mobility Requirements Study was based on current military doctrine that does not reflect the use of small, austere airfields. According to Air Force officials, when the C-17 is fully operational, the Army will change its doctrine to incorporate the C-17's short field capability. Army officials told us that until an operational C-17 squadron is fielded, the Army will not begin to plan for the aircraft's capability. In addition, the Mobility Requirements Study does not reflect the use of small, austere airfields since this capability is not a major factor in the southwest Asia or Korean scenarios.

Scope and Methodology

In monitoring issues related to the C-17 program, we reviewed the number of reported airfields that the C-17 can land at compared to the C-5. We analyzed airfield information contained in both the worldwide Defense Mapping Agency database and the Air Mobility Command database of airfields that have been assessed for military airlift. We did not independently verify agency data used in these reports.

We considered runway length, width, strength, and type of surface to assess the number of airfields available to both aircraft. We based our analysis on the published wartime landing performance criteria for the C-17 and the C-5. We discussed the issues contained in this report with officials from the Defense Mapping Agency and the Air Mobility Command. We discussed the results of our analysis with officials from the offices of the Secretary of Defense and the Air Force.

We conducted our review between November 1993 and July 1994 in accordance with generally accepted government auditing standards.

As agreed, we did not obtain written agency comments. However, we discussed a draft of this report with DoD and Air Force officials and incorporated their comments where appropriate.

We are sending copies of this report to the Secretaries of Defense and the Air Force, the Director of Office of Management and Budget, and other interested parties. Copies will also be made available to others on request.

If you or your staff have any questions concerning this report, please contact me at (202) 512-4841. Major contributors to this report are listed in appendix II.

A handwritten signature in cursive script that reads "Louis J. Rodrigues".

Louis J. Rodrigues
Director, Systems Development
and Production Issues

Countries Where the C-17 Has an Airfield Advantage

		C-5	C-17	Advantage for C-17
Europe	Germany	69	75	+ 6
	Norway	24	28	+ 4
	Portugal	15	18	+ 3
	Greece	29	31	+ 2
	Turkey	29	31	+ 2
	United Kingdom	67	69	+ 2
	Belgium	16	17	+ 1
	Faroe Island	0	1	+ 1
	Greenland	3	4	+ 1
	Iceland	3	4	+ 1
	Italy	42	43	+ 1
	Slovenia	2	3	+ 1
	Middle East	Iran	27	28
Saudi Arabia		39	40	+ 1
Asia	Japan	64	82	+18
	Korea	24	30	+ 6
	Cambodia	3	4	+ 1
	Kwajalein	1	2	+ 1
	Vietnam	8	9	+ 1
	Azerbaijan	4	5	+ 1
Antarctica		1	3	+ 2
North America	United States	658	688	+30
	Canada	74	94	+20
Central & South America	Colombia	32	39	+ 7
	Bolivia	8	12	+ 4
	Peru	18	21	+ 3
	Cuba	18	20	+ 2
	El Salvador	2	4	+ 2
	Bahamas	10	11	+ 1
	Chile	13	14	+ 1
	Dominican Republic	4	5	+ 1
	Dominica	0	1	+ 1
	Guatemala	4	5	+ 1
	Honduras	4	5	+ 1
	Panama	4	5	+ 1
	Paraguay	3	4	+ 1
	St. Vincent	0	1	+ 1

(continued)

**Appendix I
Countries Where the C-17 Has an Airfield
Advantage**

		C-5	C-17	Advantage for C-17
Africa	Somalia	5	9	+ 4
	Chad	8	11	+ 3
	Sudan	7	9	+ 2
	Egypt	24	25	+ 1
	Mozambique	2	3	+ 1
Total airfields in countries where the C-17 has an advantage		1,368	1,513	+145
Total airfields in countries where the C-17 has no advantage		830	830	+ 0
Total airfields that did not meet wartime landing criteria		585	440	
Total airfields		2,783	2,783	

Major Contributors to This Report

**National Security and
International Affairs
Division, Washington,
D.C.**

Thomas J. Denomme, Assistant Director
James A. Elgas, Evaluator-in-Charge
Steve Martínez, Senior Evaluator

Ordering Information

The first copy of each GAO report and testimony is free. Additional copies are \$2 each. Orders should be sent to the following address, accompanied by a check or money order made out to the Superintendent of Documents, when necessary. Orders for 100 or more copies to be mailed to a single address are discounted 25 percent.

Orders by mail:

**U.S. General Accounting Office
P.O. Box 6015
Gaithersburg, MD 20884-6015**

or visit:

**Room 1100
700 4th St. NW (corner of 4th and G Sts. NW)
U.S. General Accounting Office
Washington, DC**

Orders may also be placed by calling (202) 512-6000 or by using fax number (301) 258-4066.

Each day, GAO issues a list of newly available reports and testimony. To receive facsimile copies of the daily list or any list from the past 30 days, please call (301) 258-4097 using a touchtone phone. A recorded menu will provide information on how to obtain these lists.

**United States
General Accounting Office
Washington, D.C. 20548-0001**

**Bulk Mail
Postage & Fees Paid
GAO
Permit No. G100**

**Official Business
Penalty for Private Use \$300**

Address Correction Requested

