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Ground Forces Battle Casualty Rate Patterns

The Empirical Evidence

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13. ABSTRACT *(Maximum 200 words)*

A 4-year study of modern conventional ground operations (reported in 3 volumes: LMI FP703TR1/-TR2/-TR3) reveals patterns of personnel battle casualty rates strongly associated with patterns of operations. The first volume focuses mainly on discussing empirical evidence of rate patterns drawn from World War II, Korea, the Middle East wars, and the U.S. Army's National Training Center. Overall, the research combines insights from military theory, history, and operations research to investigate a new and large body of empirical data (much of it included in this volume) on battle casualty rate behavior in modern conventional operations. Findings include detailed and general rate characteristics associated qualitatively and quantitatively with major forms of cnventional operations. Qualitative indicators include critical operational parameters for rate assessment, and fundamental operational scenario characteristics. Quantitative indicators include probable ranges of average (mean) rates for army and corps-size forces for varying time periods and scenarios, distributions (max, 75, median, 25, min) of 1-day rates given those averages (for 5- and 10-day periods), measures of rate variability, rate frequencies, varying proportions of wounded casualties out of total, etc. Findings suggest that current U.S. and Allied casualty estimation methodologies and contemporary simulations fail to represent significant empirically-indicated rate patterns, and further suggest the character and degree of the misrepresentation. Improved approaches are described to casualty estimation (to evaluate estimates made by whatever method or to construct estimates). [Note: a separate paper by the author summarizes and elaborates on the research (including descriptions of how to use the data and patterns to critique simulation output), and discusses Operation Desert Storm results in light of the study's prior insights into rate patterns. See "Ground Forces Battle Casualty Rate Patterns: Uses in Casualty Estimation and Simulation Evaluation," prepared for the Military Operations Research Society, October 1992. Also in DTIC.]

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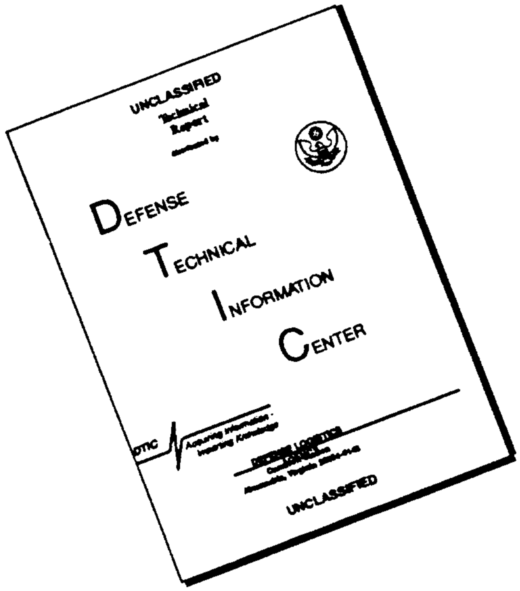

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George W. S. Kuhn

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PREFACE

This interim report is the first of three we will issue on the subject of ground forces casualty rates. Each report will later be issued as a final report. We would therefore encourage readers to communicate their comments, and any questions or suggestions, as they receive the interim reports. The subject is complex, and we have been unable to include all relevant data and supporting information in this report. Reader response will help identify issues or points that may need clarification or elaboration or, of course, further consideration.

We believe the databases developed for this study represent a potentially valuable resource for the greater analytic community. The databases will be published as soon as the data can be placed into suitable form. Our intent is to make the databases available on diskette (dBASE III Plus or ASCII text file).

LMI

Executive Summary

GROUND FORCES CASUALTY RATE PATTERNS
The Empirical Evidence

Personnel casualty rates drive planning requirements for medical force structure, replacements, and the training base. They also play a primary role in assessing a force's potential effectiveness in various scenarios, hence its likelihood of success in pursuing national policy.

This task's purpose is to evaluate the reasonableness of battle casualty rate projections by the Services and theater commands. We will issue three reports on ground forces casualty rates. This first one presents findings about ground forces casualty rates gleaned from a large body of newly developed empirical data, and compares current U.S. Army and U.S. Marine Corps projections for a European scenario to those findings.

The task grew out of longstanding uncertainty within the Office of the Secretary of Defense (OSD) about whether casualty rate projections are reasonable and, if not, as to how far and in what direction (low or high) they may be outside a reasonable range.

We find that many current projections of battle casualty rates are inconsistent with the empirical evidence of rates for modern ground forces – evidence from both actual combat and recent field exercises. First, peak rate periods in certain major projections appear consistent only with a theater scenario radically altered from the one assumed in policy planning. Such peak rates suggest a U.S. sector within the NATO front that has probably been broken by attacking forces, rather than one whose defensive integrity remains basically intact despite being hit hard.

Second, most current projections show either stable or declining rates after an initial peak rate period. Yet the empirical evidence is clear that if significant combat continues after an initial period, it will result in multiple peaks.

Finally, current projections show wounded-in-action hospital admissions as a relatively constant proportion of total battle casualties. Yet the evidence shows that, in key combat scenarios now envisioned for Europe, the proportion of wounded admissions would decline significantly while that of missing and captured would rise equally dramatically.

Any one of these inconsistencies between current projections and the empirical evidence represents a serious breach with planning assumptions, with equally serious implications for requirements. The principal U.S. Army projections for Europe exhibit all three inconsistencies. U.S. Marine Corps projections for Europe are mixed. One shows consistency with the empirical evidence for a single peak rate period, but is otherwise inconsistent; the other major projection is inconsistent both with the first projection and with the empirical evidence.

Our conclusions rest on data from Allied and German experience in World War II, from the Korean and Middle East wars, and from contemporary field exercises pitting U.S. against Soviet-style units.

The data clearly show two things. First, daily casualty rates in modern conventional ground warfare exhibit distinct pulses associated with significant daily variability. Figure-1 illustrates the kind of pulse and variability *patterns* seen in divisional casualty data from actual combat. Rates for corps and armies show, as expected, lower peaks and variability but similarly dramatic ones.

Current projections generally fail to reflect these real-world patterns, either explicitly or implicitly. Consequently, they often show 10-day peak rates for a theater-size force of divisions that are higher than the scenario warrants. Yet, at the same time they do not account for the fact that some divisions in the force will experience considerably higher peak rates than projected, while all divisions in the force will experience many more lower 1-day rates than projected.

Second, the data provide no evidence that casualty rates *for a given situation* have increased significantly, if at all, since World War II. This is contrary to common intuition, which focuses on obvious increases in weapons' lethality but usually

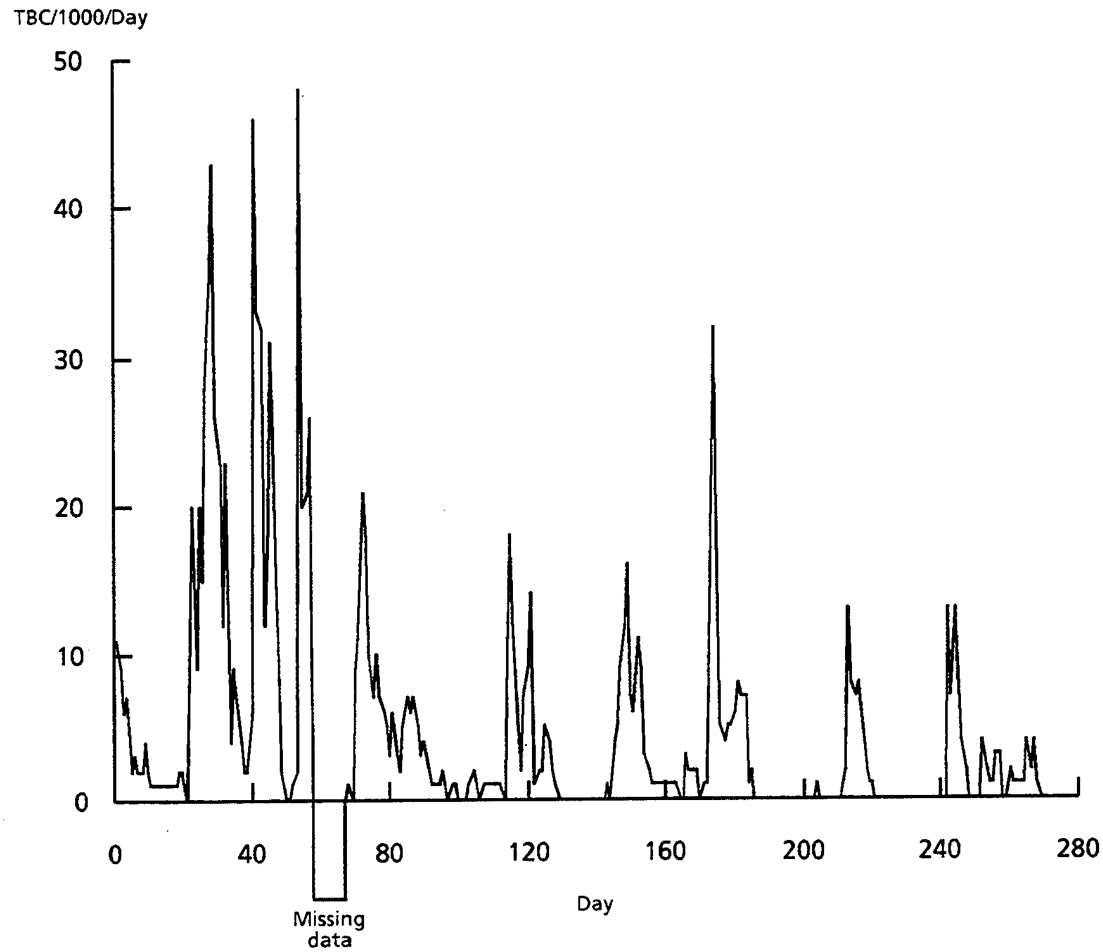

FIG. 1. 30th U.S. INFANTRY DIVISION (June 1944-April 1945)
Total Battle Casualties (TBC) per 1000 personnel per day

understates or ignores other developments that counteract such increases. The fact is that casualty rates for ground combat have reduced by a full magnitude over the past 400 years. That the evidence shows they have not increased since World War II simply fits the longer trend.

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CHAPTER 1

INTRODUCTION

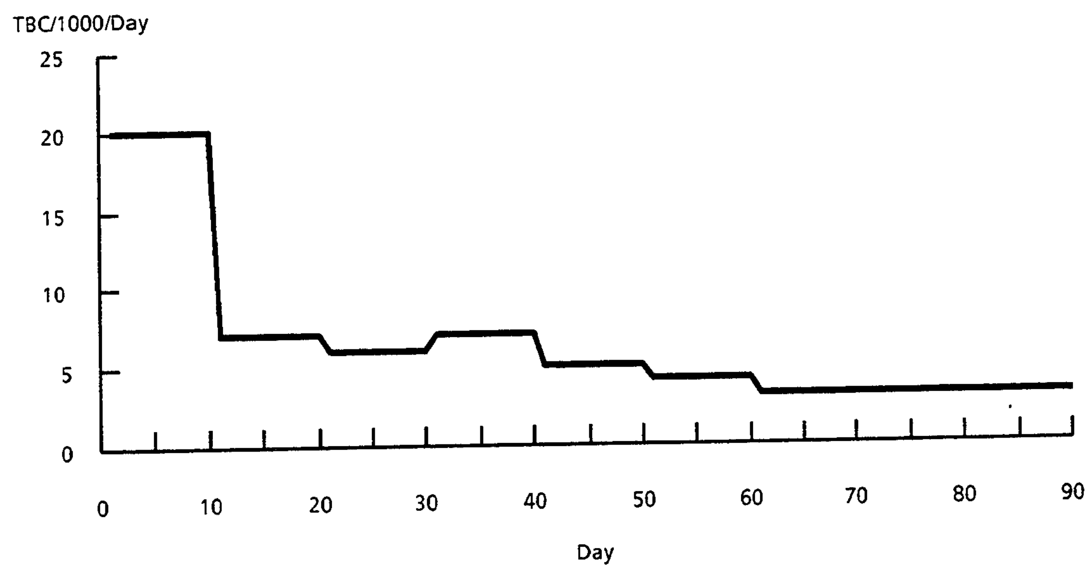
This report is the first of three to address the reasonableness of projected battle casualty rates for modern ground forces in conventional combat. The report presents our analysis of a large body of newly collected empirical evidence of ground forces casualty rates and identifies patterns in those rates that are useful in assessing contemporary rate projections.[1]

This study of ground forces casualty rates is part of a larger ongoing effort, directed by the Office of the Secretary of Defense (OSD), to study current casualty estimates. The general task is to evaluate the reasonableness of personnel casualty estimates made by both theater commands and the Military Services. These estimates are used for planning purposes, mostly affecting personnel replacement and medical requirements. But estimates of attrition also play a key role in both generating and assessing many other requirements.

SCOPE OF GROUND FORCES STUDY

The ground forces subtask focuses on projected rates for U.S. Army and U.S. Marine Corps forces in the European theater. The projections of particular concern are those for the division-level portion of the full theater force; that is, they address rates for the full divisional strength of the theater force. These projections are generally made in terms of 10-day increments and cover up to 180 days. Figure 1-1 shows one such projected set of 10-day rates for Army divisions in Europe for a 90-day period.

[1]The second report will analyze the major official ground forces casualty rate projections and compare their representations of casualty rate characteristics to those gleaned from the empirical evidence. The last report will provide a suggested set of plausible casualty rate ranges – keyed to force size, time, and general scenario – for use in evaluating the reasonableness of current or future projections of ground forces rates.



NOTE: Two notes are appropriate: (1) This unclassified projection is produced for the Army staff in support of the Department of Defense's Wartime Manpower Planning System (WARMAPS), a planning instrument sponsored by the Office of the Secretary of Defense. The projection is representative of projections the Army uses internally for requirements planning in the Program Objective Memorandum (POM) process. (2) Representative classified casualty rate projections for both Army and Marine Corps forces in Europe are included in the Classified Supplement that accompanies this report.

FIG. 1-1. U.S. ARMY PROJECTION OF EUROPEAN THEATER FORCE (DIVISION-LEVEL) Total Battle Casualty (TBC) Rate Per 1000 Personnel Per Day

The question raised by this particular chart is whether the incremental rates shown might reasonably be expected of a U.S. Army theater force of divisions in Europe. Such a force may range in size from about 10 divisions during the first 10 days, to perhaps 20 or more divisions (depending on scenario assumptions) as time passes. The curve suggests, in essence, that in the first 10-day increment each of the force's divisions will sustain a personnel casualty rate of 20/1000/day for each of the 10 days. That average rate will then fall as the curve depicts for the following time increments, as the war continues and the force size grows.

Scenarios and force sizes of course change. The ground forces subtask will eventually evaluate projected rates for the major set of scenarios and force sizes currently envisioned for the European setting.

SCOPE OF REPORT

This first ground forces report addresses casualty rates for modern conventional combat in a European-type setting. The report describes the nature of these rates through both quantitative and qualitative characterizations of the empirical evidence. The report concludes with an assessment of whether the thrust of this evidence supports current casualty rate projections for U.S. Army and Marine Corps forces in Europe. No attempt is made in this report to conclude whether there may be substantial and adequate reasons outside the empirical record that would support the projected rates.

OUTLINE OF REPORT

The reader may wish to proceed directly to the heart of the report: the key concept (Chapter 4), findings (Chapters 6-10), and conclusions (Chapter 11). The remainder of this report takes the following form.

Chapter 2 Task Background

Describes the original concerns in OSD leading to the overall task, the reason for the focus on ground forces casualty rates, and the general kinds of casualty estimates at issue.

Chapter 3 Methodology: An Empirical Approach to Evaluating Casualty Rates

Describes key methodological considerations, including the need for perspective in terms of the operational level of war, the basic framework for comparing empirical data, and the kind of empirical data used.

Chapter 4 Casualty Rate Patterns

Introduces the key concept of the pattern that characterizes ground forces casualty rates in modern conventional combat.

Chapter 5 The Empirical Data

Describes why extensive new databases were developed for this study, and what they include.

Chapter 6 Pulses and Variability

Describes the pulsing and variability of ground combat casualty rates that comprise the rates' basic underlying phenomena.

Chapter 7 Quantitative Characteristics of Casualty Rate Patterns

Characterizes casualty rate patterns quantitatively, and suggests that U.S. experience in World War II provides most of the key insights for those characterizations.

Chapter 8 Major Conditions Associated with Casualty Rate Patterns

Describes the broad operational settings fundamentally associated with casualty rates and some key features of that association; further defines magnitudes and composition of rates in light of operational settings.

Chapter 9 Casualty Rates Against Soviet Operational Methods

Compares U.S. and German World War II casualty rate data and shows that German rates against Soviet operational methods were not essentially different from U.S. rates.

Chapter 10 Casualty Rates Since 1945

Shows that empirical data of casualty rates subsequent to 1945, when compared to appropriate World War II data, offer no evidence of increased rates.

Chapter 11 Conclusions

Offers conclusions about current U.S. Army and U.S. Marine Corps casualty rate projections for the European theater.

Chapter 12 Model Representations of Casualty Rates: First Indications

Suggests basic differences between the casualty rate patterns seen in actual combat and those seen in model representations of combat.

CHAPTER 2

TASK BACKGROUND

EVALUATION OF DoD CASUALTY ESTIMATES

The overall task[1] to evaluate DoD casualty estimates had several origins. Within OSD – especially within the Force Management and Personnel secretariat – it had long been observed that successive casualty estimates, even for the same theater and general scenario and produced by the same source, often differ considerably. Concern about these differences focused in 1987 largely on variations in basic assumptions (e.g., about mobilization times or about allocation of threat forces over time) used in making the estimates. It was not clear whether the differences in the assumptions were supportable or, if so, whether the evident effect of the differences on casualty rates was supportable.

Beyond questions about varying casualty rate projections, OSD suspected that the projected rates were too low. Certain projections were known to be influenced by historical casualty rate data, and these data seemed certainly to be outdated with advances in weapons lethality. Another major concern was that, in any case, American forces had not faced Soviet conventional forces or operational methods. German experience on the Eastern Front in World War II seemed to offer prima facia evidence that Soviet forces and methods must surely result in higher casualty rates.

These longstanding concerns were highlighted in 1986 – 7 when then-Assistant Secretary of Defense (Reserve Affairs) [ASD(RA)] James Webb questioned current U.S. casualty estimates for Europe. He found the fact that West German and British estimates of casualty rates seemed higher a cause for concern that U.S. estimates were probably too low. He noted that medical support had been seriously lacking early in the Korean War and might be again.

These more particular concerns were accompanied by a general sense of uncertainty as to how any particular estimate was produced in the first place. While

[1]LMI Task Order FP703, *Evaluation of DoD Casualty Estimates* (originally signed in February 1987).

the methodologies could be described generally, the factors accounting for differing estimates often seemed virtually opaque to outside understanding. Also, it was generally accepted that certain types of combat activity were not well represented in the estimating procedures.

THE GROUND FORCES: DEVELOPMENT OF STUDY FOCUS

Our initial review of the Services' and theater commands' casualty estimates and estimating approaches led to several judgments. The first was that ground forces estimates should be studied in depth before turning to naval or air estimates. The great majority of projected casualties are understandably in the ground forces. But other factors also pointed to the early focus on ground forces estimates.

Considerably more work had been done on casualty estimation in the ground combat arena, mainly by the Army but also by independent analysts, than in the naval and air arenas. More data seemed available for study. And considerably more theoretical work had been devoted over many years (both in the United States and abroad) to the nature of ground warfare phenomena. This theoretical work provided insights critical to assessing the adequacy of existing analyses and databases. (Later, these insights were equally critical to structuring a useful analytic framework and thus setting up a promising data collection effort.)

The overview's survey of existing ground forces' casualty data and of the theory of modern conventional combat's structure and dynamics suggested that, contrary to initial expectations, casualty estimates might be too high. The possibility that ground forces casualty rates could be either too low or too high, each by a significant extent, presented a problem that OSD agreed could only be addressed through a far more detailed investigation than we had originally contemplated.

New data on ground combat casualty rates had to be collected, for the overview also revealed that no existing ground forces casualty databases (either alone or in combination) would support the needed analysis. Existing databases were built on various analytic frameworks and thus, for example, counted differently such critical factors as strength, casualties, levels of force engaged, and duration of combat. Moreover, none of the databases permitted sufficiently careful analysis of the critical issue, "Are projected rates, based on 10-day increments covering a total period of up to 180 days, reasonable for a theater force?" Existing databases were heavily weighted toward short-term battles between tactical units, not toward data about a full theater force over long periods.

Finally, decisions were made to focus on Europe, on conventional war, and specifically on battle casualties (killed-, wounded-, and missing-in-action). It was not clear whether data collected to evaluate rates in a European setting would be useful for other settings. It was clear that, if any theater needed a major effort first, it must be Europe. Very little work had been accomplished by 1987 on projecting casualty rates due to nuclear, biological, or chemical agents; and little data seemed available. The decision to set aside the problem of disease and nonbattle injury casualties (DNBI) proceeded from a combination of funding limitations, the fact that DNBI analysis probably required a separate body of expertise from that underlying battle casualty analysis, and not least from the strong presentation by the Army's Surgeon General staff that DNBI rates have far less effect on medical (or, by implication, replacements) requirements than do battle casualty rates.

MAJOR EXISTING BATTLE CASUALTY RATE PROJECTIONS

Three principal sets of battle casualty rate projections drive requirements planning. The WARMAPS, a planning instrument sponsored by the OSD, provides planners with a relatively detailed overview of manpower requirements by theater and in 10-day increments over a 180-day period. It assumes the Defense Guidance (DG) planning scenario, and addresses personnel estimates for both the near (first) year and the far (fifth) year of the annual 5-year plan.

WARMAPS estimates are in fact projections of casualty rates and populations-at-risk first prepared by the Services and annually fed into the WARMAPS system. These Service estimates generally support internal Service POM planning for medical force structure and personnel replacements requirements. Each Service uses a different estimating methodology.

Finally, each theater Commander-in-Chief (CINC) provides casualty estimates for his major operations plans (OPLANs). These estimates are made by the theater command's medical or personnel staff using a methodology approved by OSD and the Office of the Joint Chiefs of Staff (OJCS). The planner applies Service-approved casualty rates against the OPLANs' populations at risk. The approved rates (number of casualties per 1000 personnel per day) describe rates thought to apply to five levels of combat intensity for forces in the operations zone(s). The planner selects a sequence of intensity levels, assigning each a time period judged to reflect an OPLAN's scenario and course of events.

The OPLAN scenario may or may not assume the DG scenario. The approved casualty rates used in the theater OPLAN process may or may not match those used by the Service in its 5-year POM planning process or those in the estimates provided by the Services to OSD under the WARMAPS process.

CHAPTER 3

METHODOLOGY: AN EMPIRICAL APPROACH TO EVALUATING CASUALTY RATES

GENERAL REMARKS

Evaluating what constitutes reasonable casualty rate projections requires first acknowledging the fundamental uncertainty inherent in casualty phenomena. No prediction that takes the form of a single point value can be considered simply correct. At best, a range of rate possibilities may be identified as associated with certain parameters with reasonably high assurance. The overall ground forces methodology was developed to clarify, in necessarily broad but still useful terms, the character of casualty events in this realm of uncertainty.

Two considerations become paramount. First, uncovering the nature of casualty phenomena requires looking at empirical evidence of their occurrence, not merely at mathematical models or other representations of the phenomena. Only empirical data can reflect the array of casualty rate possibilities inherent in such a probabilistic realm as combat, hence the manner or character of the rates' occurrence. Second, assessing theater rates requires that the evidence observed must represent the operational level of war, not merely tactical events.

STUDY APPROACH

We rest our study of ground force casualty rates on three legs: modern conventional combat history, contemporary field exercise results and models and other representations of combat. See Figure 3-1. Extensive effort has gone to arriving at a way appropriately to analyze casualty rates as shown in each of the three areas and to compare the results. The common thread is to compare rates sustained by comparably sized forces over comparable time periods in comparable general settings.

The present report addresses two of the three legs: modern combat history and contemporary field exercises, the two empirical legs. The report concludes by directly

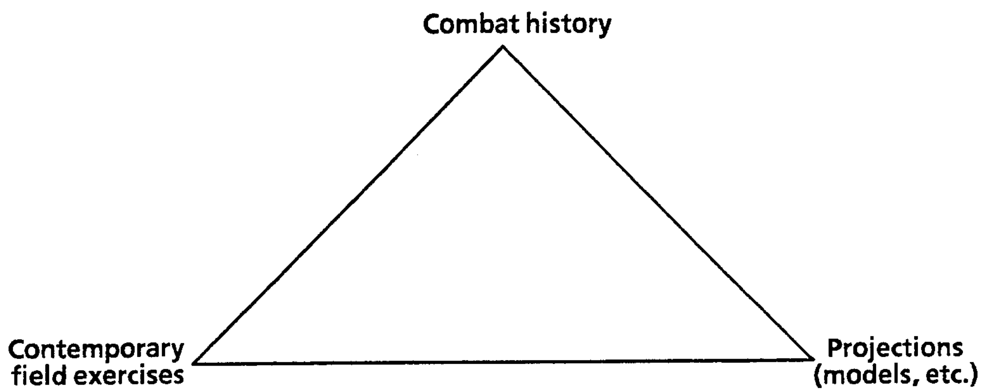


FIG. 3-1. LMI THREE-PRONGED APPROACH

comparing rates projected by the major current methods to the insights gained about rates in the empirical evidence of their occurrence.[1]

KIND OF EMPIRICAL EVIDENCE USED

This study places heavy emphasis on empirical evidence of casualty rates. Only such data provide direct evidence of casualty rates as they actually occur, without the artificialities necessary to any representation of combat. The same reasoning of course requires that, within the body of empirical evidence itself, the emphasis is clearly on actual combat results.[2]

A spectrum of empirical evidence relating to casualty rates exists. At one end is evidence about weapons' effects available mainly from the results of closely controlled experiments. This empirical evidence of quantifiable weapons' behavior clearly attests to advances in effectiveness when older and newer weapons are measured side-by-side in terms of their effects.

[1]A final evaluation of current estimates of possible future ground forces casualty rates awaits fuller insights into the major factors informing projection methodologies and analysis of plausible rate patterns in various scenarios.

[2]As discussed in Chapter 10, field exercise results are consulted both because they offer a view of rates possible between contemporary forces that is widely regarded as realistic, and because they serve as a check of insights into rates gleaned from real combat data. This study treats them in the latter capacity – as confirmatory indicators only – and not as the primary basis of any conclusions offered.

These empirical results are often then taken a step (or more) out of the empirical spectrum. Characterizations of weapons' effectiveness – that is, of their casualty producing performance in operational settings – are attempted. These are usually arrived at by placing the empirical data on weapons' effects into mathematical models that characterize an operational scenario. The model characterizes the many kinds of variables present in such a scenario and also the manner of these variables' interactions. The model thus characterizes the casualty production of the weapon as its effects play out in the modeled operational setting.

These characterizations of weapons' effectiveness (which include, for example, probabilities of hit or kill) are vital in the set of higher-level models and analyses that underlie casualty estimates. Every effort is made to ensure the weapons' data reliably represent the weapons' possible effectiveness. But these data are, at this point, no longer empirical.

At the other end of the empirical spectrum is evidence of casualties sustained by forces in actual operations. These casualties (excluding most of those missing and captured) are caused by munitions effects, primary and secondary, as they play out in the actual processes of combat. The myriad variables that interact in combat, in the immense variety of their possible interactions, govern how the weapons' effects result in actual casualty counts.

The great question is whether the manifest advances in weapons' effectiveness measured in terms of effects in controlled conditions – not to mention improvements in target identification and acquisition, effective ranges, etc. – translate into similarly increased *operational* effectiveness measured by some proportionately greater casualty rate sustained by forces in actual operations. Many believe the answer must be affirmative.

But the evidence is clearly to the contrary. It has been demonstrated – most recently (and mainly) by Trevor N. Dupuy – that rates of casualties in ground warfare have declined by a full magnitude since the 17th century, despite increases in weapons' lethality that dwarf those of conventional arms in the past generation (see Figure 3-2).

Many find this trend counterintuitive. But it is too well documented to dispute. Its basis had also been widely and well described as resting in the numerous developments – such as in steadily increasing unit and personnel dispersion, increasing

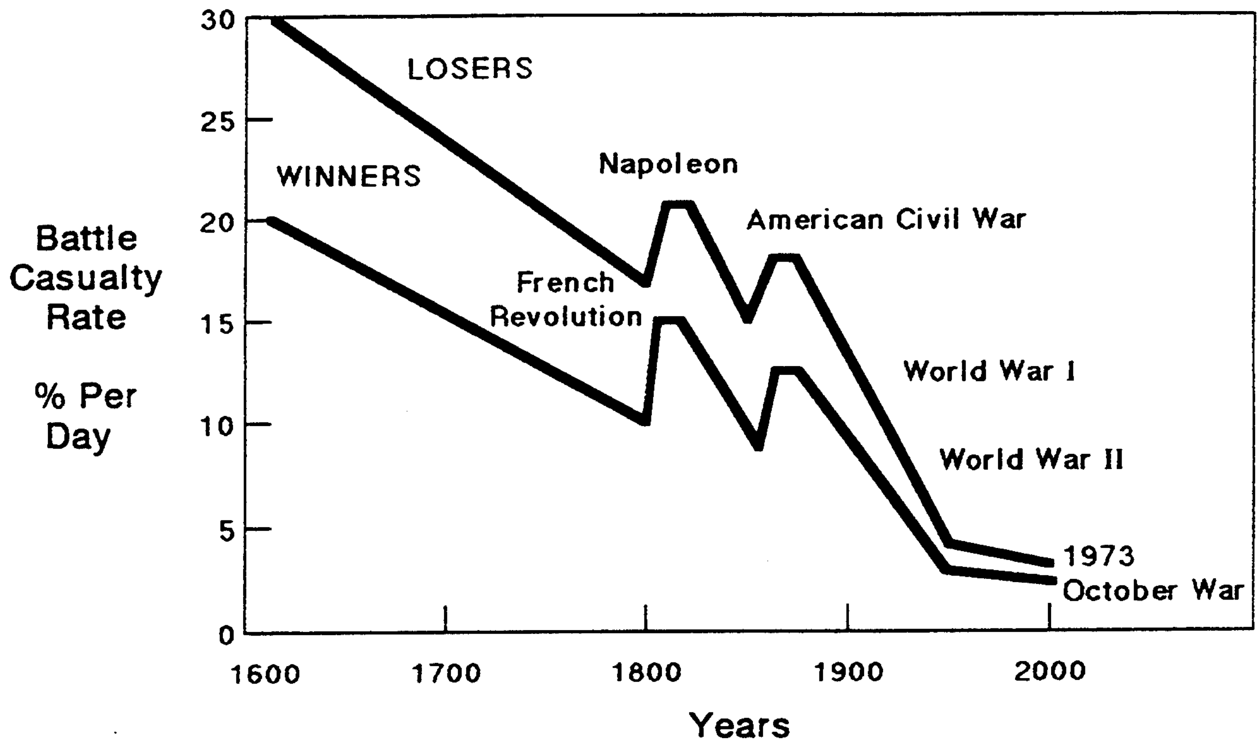


FIG 3-2. AVERAGE DAILY BATTLE CASUALTY RATES, 1600-1973 (T. N. DUPUY, 1986)

mobility, increasing protection, etc.[3] – that have accompanied or followed (or preceded) developments in weapons lethality and targeting. In other words, weapons effectiveness when measured in terms of casualty rates caused in actual operations must take into account far more than just the technological features of the weapons themselves.

This study thus distinguishes between "operational"[4] empirical data on casualty rates and what we will call "technological" data. The former is defined to include data from the operations of actual units, mainly in real combat but also in

[3] These and similar physical factors are critical to reduced casualty rates. It has also been suggested that increased physical dispersion of personnel leads to a decreased ability or willingness on the part of individuals out of touch with comrades to sustain high casualty rates.

[4] The term "operational" has at least three meanings in military affairs. It can be opposed to other perspectives, such as "technological." It can also refer to particular military events in the sense of any given battle or engagement or the like, and to the activities associated with them. And, in more recent times, it refers to a level of war at which "operations" are conducted that are characteristically different from "battles" or "engagements." The operational level of war stands between the "strategic" and "tactical" levels of war.

field exercises that simulate combat operations arguably well. Technological data are viewed as those that represent either the true empirical results of weapons experiments or the extensions of such results to characterizations of weapons effectiveness in terms of casualty production probabilities.

This study focuses on operational empirical data of casualty rates in modern ground combat.

NECESSARY PERSPECTIVE: OPERATIONAL LEVEL OF WAR

A major problem with many existing casualty databases of modern ground combat, and therefore with the historical data used most often to evaluate the reasonableness of casualty rate projections for modern ground operations, is that they are focused on tactical experiences – for the most part, battles lasting 1 to 3 days and involving at most a few divisions (usually a smaller force) on each side. They do not show the relationship of various rates experienced across the larger front during the battle. And they do not indicate how the larger front's overall or average rate behaves over a longer period of time given the varying complex structures of tactical actions – engagements, battles, campaigns; offensives, defensives, counteroffensives; etc. – possible over that longer time line. Yet it is precisely this problem that confronts military planners in a European scenario: assessing the reasonableness of rates for a force composed of numerous divisions across a broad front over periods ranging from 10 to 180 days. This is the operational level of war.

Military theorists have long distinguished the operational from the tactical level of war. Research under this Task indicates that, while tactical and operational actions share certain general characteristics regarding casualty rates, there are also some distinct differences. Casualty rates at the two levels of war must be understood in their own terms. And, if an operational-level front is active, tactical actions within that front must be understood in terms of the larger operational-level whole.

FRAMEWORK FOR ASSESSING CASUALTY RATES

The collection of data for this study was made in light of both the need to "flesh out" the kinds of casualty patterns that might be associated with certain broadly definable operational parameters and the need to compare data from different settings and eras.

Key Parameters

We identified three parameters as basic to understanding patterns of casualty rates: echelon (or size of force); time (period over which a rate is measured); and sector (along the front, but also referenced to the broader operational setting or scenario). See Figure 3-3. Casualty rate data need to be seen simultaneously in terms of all three parameters: each rate set into its place in the 3-part framework, and the characteristics of rates throughout the framework identified.

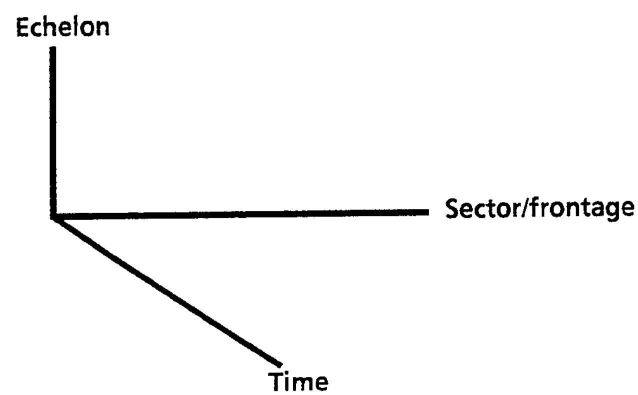


FIG. 3-3. KEY PARAMETERS TO UNDERSTANDING CASUALTY RATE PATTERNS

The framework matches like data to like data, and thus permits comparisons both within combat eras (e.g., different forces within World War II) and between combat eras (e.g., Middle East versus World War II).

Databases in Terms of the Key Parameters

Figure 3-4 places the main data sets developed for the study into the scheme depicted in Figure 3-3. This display offers a view of how the databases' contents generally relate to each other.

Key Parameters in Operational Setting

More important, the framework of parameters must be considered in terms of a notional picture of a dynamic operational setting. We call this "The Notional Casualty Rate Pattern," described in Chapter 4. The concept of casualty rate

Main Databases

ECHELON	12 AGp	21 AGp	US - Italy	German	Battles	Korea	Middle East	NTC
AGp	●	●						
Army	●	●	●	●				
Corps	●	●	●	●		●	(●)	
Division	●	●	●	●	●	●	●	
Regiment/ Brigade					●	●	●	
Battalion					●			●
SECTOR/ FRONTAGE	T-O	T-O	T-O	T-O	T	T-O	T	T
TIME: Short Term (1-day to weeks)	D	D	D	(Few D) / $\bar{D}$ in 10-day blocks	D / $\bar{D}$ in varying-day blocks	D / $\bar{D}$ in varying-day blocks	D / $\bar{D}$ in 2,3,4-day blocks	D
TIME: Long Term (months to years)	D	D	D	$\bar{D}$ in 10-day blocks		$\bar{D}$ in varying-day blocks		
	1944 - 1945	1944 - 1945	1943 - 1945	1941 - 1945	1943 - 1945	1950 - 1953	1967, 1973	1985 - 1988

←——— World War II ———→ (1944 - 1945 through 1943 - 1945)

Dimension	Predominant Data
Echelon	● = Represented (Note = roughly defined in terms of U.S. WWII force sizes)
Sector/ Frontage	T = Tactical Sectors/Frontages O = Operational Sectors/Frontages
Time	$\bar{D}$ = Average "Daily" Rates D = Actual Daily Rates ( ) = Limited Coverage

FIG. 3-4. DATABASES IN TERMS OF KEY CASUALTY RATE PARAMETERS

patterns expressed in Figure 4-1 is fundamental to understanding the behavior of casualty rates.

STUDY DESIGN

The study divides into two broad parts. First, empirical evidence was sought of any patterns of casualty rates that might be characteristic of combat when defined in terms of the given parameters (echelon, time, and sector). Second, empirical evidence was sought to ascertain whether rates for those echelons, time periods, and sectors might have changed significantly over the past half century.

We began with detailed analysis of World War II data. Only World War II provides extensive evidence of combat between theater level conventional forces using essentially modern weapons, force structure and approaches to operations. Data from the U.S. 12th Army Group provide the fullest and most detailed view of the nature or shape of theater level casualty rates across different echelons, times, and sectors. These data thus became the fundamental source of information on the details of casualty rate patterns.

But an important question was whether the 12th Army Group experience – more precisely, whether portions of that experience selected from appropriate contexts – might also comprehend patterns of modern conventional ground forces casualty rates more generally. For example, do the rate patterns discerned in the 12th Army Group's experience also describe the casualty rate experience for other forces when those experiences are compared in terms of the appropriate echelon, time, and sector?

To answer this, data from other but roughly comparable operational environments were collected. The 12th Army Group data were first extensively compared to other World War II casualty experiences, both to other Western experience (British and American)[5] and to German experience. Comparisons were then made with experiences in subsequent eras (Korea, the Middle East, and contemporary field exercises). Of particular concern, of course, was whether casualty rate experience in the face of Soviet operational methods differed or was consistent when viewed, again, in terms of the appropriate echelons, times, and sectors. (Data

[5]Data on battles or larger time periods were drawn from experiences of forces in the 7th U.S. Army in Central Europe and Sicily, the II U.S. Corps in North Africa, the 5th U.S. Army in Italy, and the British 21st Army Group in Europe and 8th Army in North Africa.

from German experience on the Eastern Front were especially helpful, with regard to the latter concern, in supplementing the insights from the 12th Army Group.)

Only two databases other than the 12th Army Group database represent the daily experience of large groupings of divisions over long time periods – the British 21st Army Group and the set of American divisions in Italy. Given that these sources are weaker with respect to certain data than is the 12th Army Group database, they were used mainly as a general check on the latter by seeking any casualty rates that were anomalous in terms of the 12th Army Group data. A similar check was made using the German data, reviewing it both in its entirety (across all divisions, corps, and armies in their 10-day blocks) and in greater detail for 12 major Eastern Front campaigns.[6]

Once we established that the 12th Army Group experience did indeed comprehend – again, when contexts were appropriately compared – the experiences of theater-level forces in differing scenarios, it was necessary to determine whether subsequent combat suggests significantly different (especially, higher) casualty rates. Thus, data from operations subsequent to World War II were then compared to appropriate portions of the World War II (12th Army Group) data. These comparisons included data from the Korean War, the Middle East wars, and contemporary field exercises at the Army's National Training Center.

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[6]As described in Chapter 5, under "Descriptions of Empirical Databases," the German data afford a view mainly of 10-day time blocks. Therefore, the daily variability of rates could not be determined. But the 10-day blocks of casualties could be compared to 10-day blocks from the 12th Army Group database. All the aspects of casualty rate patterns could not be determined, but certain elements of the patterns could be discerned – for example, rate magnitudes for 10-day time periods, the general rise and fall of such magnitudes over time and across a higher level force (such as an army), the magnitudes sustained in certain kinds of sectors and overall scenarios, and so on. If these kinds of comparisons revealed rate consistencies, the presence behind the German rates of patterns of the underlying rate phenomena (such as daily pulsing and variability) could be plausibly inferred. At a minimum, the comparisons would reveal whether the basic character of the German casualty rate experience – when seen in terms of comparable echelon, time, and sector – was similar to or different from that in Western experience which provides sufficient detail to characterize rate patterns.

We again stress that the comparisons require that an appropriate portion of the World War II data be extracted and used, rather than simply assuming that theater-level operations (on the scale experienced in World War II) are directly comparable to the lower level tactical operations that have dominated since 1945. Only comparable combat phenomena may appropriately and usefully be compared.[7]

Throughout the study, our analysis focuses on total battle casualties sustained per 1000 personnel strength per day. The measure of strength is, in all cases except the comparison of battalion casualty rates, the division. Thus, when single divisions' rates are analyzed or compared, the measure is straightforward. When higher echelons' rates are analyzed, the rate described is that of the aggregated line divisions assigned to that higher echelon (i.e., excluding personnel organic or otherwise attached as "overhead" to that echelon). The division strength used is the full division strength, including both combat and support personnel.

ADEQUACY OF EMPIRICAL EVIDENCE USED

The adequacy of the empirical data collected must be judged in terms of its accuracy and, probably more important, its competence to serve the purposes intended.

Historians and operations researchers know full well the impossibility of certifying that a given record of an experience is exactly accurate. Aside from the fact that any honest recorder will admit to not knowing everything about what he

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[7] The basis and extent of sameness becomes an issue when attempting to describe two combat events as comparable. Some would attempt to ensure the particulars are as similar as possible in as many respects as possible. That is appropriate for some purposes. In our judgment, however, the necessarily imprecise character of casualty rates – for example, their extreme variability even for the same unit on a succession of days against the same enemy and in very similar circumstances – leads to the conclusion that the proper basis of comparability is necessarily rough at best. Moreover, it ought to be rough. Insistence on identity of details robs the comparison of its potential robustness. Predicting the details of some future scenario is impossible. Ensuring identity of details for past scenarios is nearly equally impossible. For precisely this reason, use of empirical casualty data to determine comparability of rates in given settings ought to focus on data drawn from settings *roughly* comparable to each other. Given the myriad interactions of casualty-related variables possible in these roughly comparable settings, this procedure ensures a range of rate possibilities associated with the settings. Thus, a robust set of rate possibilities is identified as associated with the settings. This becomes the basis of the range of rates identified for that roughly defined setting. Insistence on identity of details simply misses the basic point about the nature of casualty rates and about the robustness of characterization consequently needed to describe that nature, even in terms of stable parameters.

records, different recorders will even see the same event differently. Still, certain rules of counting and interpretation generally govern a given set of official records of military strengths and casualties; given enough instances of records filed under generally known procedures, it is probable they will provide a reasonably accurate picture. The two real problems that can occur are the recorder's being misinformed or having to follow other rules or policies that consciously distort information.

We have attempted to respond to such concerns in several ways. First, we limited the data collection (with few exceptions) to official records of casualties and strengths. (The one major exception was the case of the Middle East conflicts – for which no official data in the form needed are available.) Second, we conducted various checks, especially with the more critical databases, to ensure reasonable consistency with other available sources. Third, in those cases where we were aware that certain data were specifically questionable (e.g., with the U.S. 106^{th} Infantry Division on its worst casualty day), we sought other sources or means to provide the truer picture. Fourth, we attempted to collect data sets large enough that particular recorders' errors or misinformation would likely be offset by the weight of other data. Finally, our analytic framework was in important respects chosen with the thought that no particular instance or few instances of a casualty rate would dominate the results of the analysis. Those particular instances that were especially instructive were of course recognized as such, but the broader analysis depended on generally occurring patterns of rates rather than on single cases that arguably could be mistaken.

The question of accuracy at some point yields to the issue of required precision. How much precision is, after all, required for the analysis to reveal meaningful information and to support significant conclusions? Given reasonable controls for accuracy, the answer rests on the character of the analysis and the sensitivity of conclusions to possibly imprecise particular data.

This study addresses planning requirements driven by the character of casualty phenomena in operations. We observe that too often planners, who understandably need to work with ranges of possibility, assume such ranges can be asserted simply because they are so broad they will by definition encompass most possibilities. We believe generalizations of this sort are supportable only if the kinds of possibilities are reasonably closely defined first, and then the generalizations are made on the basis of those reasonable limits. This is especially so in cases where the possible values of the phenomenon in question are characterized by dramatic differences. Such is the case of casualty rates.

For this reason (in addition to standard concerns about the accuracy of empirical data), we early rejected an analytic approach that would stand or fall on the complete accuracy of any given datum. Our purpose is governed by the ultimate objective of supporting the planning process by assessing in a "ballpark" sense the reasonableness of 10-day blocks of battle casualty rates for a theater force of divisions. But "in the ballpark" does not mean "in the general vicinity of the ballpark or of its city." Planning within broad limits does not mean within arbitrary limits. Defining broad limits that are nevertheless reasonable broad limits requires that the nature and extent of what constitutes such limits be defined first with great care.

We determined that the critical intermediate objective must be to discern the kinds of casualty rate patterns evident in forces of varying size, time periods, and general conditions. These patterns could be distinguished by several of their features that were probably quantifiable. Such features include the general distributions of rates from "high" to "low" (allowing the data to define these qualities), the range of durations in days of varying rate values, the relationship of rates at the several echelons during the same time block, and so on.

Casualty rate patterns are especially important for their robustness as an analytic tool. If one can establish, for example, the relationship between a mean rate of casualties over a given period of time and the variability of the daily casualty rates over that same period, then one can work with any given mean rate (e.g., one may hypothetically assert some rate) and find the range of variability of daily rates associated with the new rate. Once rate patterns were defined, we could identify reasonable ranges of rates for given force sizes, time periods, and broad scenarios.

With this broad purpose and general direction, every attempt was made to ensure the patterns would be defined as fully and with as much confidence as possible. The body of data needed to be large enough to cover a broad spectrum of casualty eperience and thus establish the character of rate patterns with confidence. This led to a principal database (the U.S. 12th Army Group) that provides the daily experience of up to four field armies, 12 corps, and 51 divisions during 9 months of combat. These data cover 8,297 division days, 2,222 corps days, 804 army days and 212 army group days. Another principal database (The German Army), used mainly as a check against the first, covers 4 years of war with the casualty experience of more than 270 divisions in 5,399 10-day time periods. Other databases, inevitably less extensive, served related purposes, such as more fully defining patterns or ranges of rates at different echelons or comparing rates from different eras.

Our final concern regarding the issue of required precision turned on the comparability generally of modern conventional ground forces themselves, especially in terms of the manner of their operations and structure.

Our understanding of the basic theoretical work done on the nature of modern conventional ground force operations (and related force mixes and structures) led us to conclude there is far more that persists in these respects in modern war (since the early 1940s) than has changed. Given that, patterns of rates that help reveal the ebb and flow of combat under modern conditions will likely apply to conventional war under foreseeable conditions. The possibility of course always exists that significant differences have been introduced – though, often, such "differences" are more of the nature of promised improvements of significant effect than likely ones. Still, the potential effect of such differences on casualty rates in 10-day time blocks at the theater level can be gauged by various hypothetical excursions that keep in mind the kinds of rate patterns that empirical evidence shows are associated with various force sizes, time periods, and broad scenarios.

Finally, our approach to the analysis, given all these considerations, demanded that we be as conservative as reasonable at every step. Throughout, we acted so that if there were any bias that might attend a decision about the data, it would lean toward a conservative statement of rates for the particular issue at hand. One major focus of our concern, for example, is on 10-day rates for a contemporary army-sized force composed mostly of heavy (mechanized and armored) divisions. The World War II rates used to help understand army-level rates are drawn from forces composed mostly of that era's infantry divisions. The data are clear that armored divisions sustained on average significantly lower personnel casualty rates (this does not address equipment loss rates) than did infantry divisions. Since today's heavy divisions more closely resemble World War II armored divisions in such key respects as armor protection and mobility, the proper comparison in one sense would be with those armored divisions. However, the real concern is with casualty rates for army-sized forces. Casualty rates of infantry-heavy armies provide a reasonably conservative standard against which to judge contemporary army-level rate projections, even allowing that rates for today's heavy divisions might be significantly higher than rates for the older armored divisions. Such decision points concerning the choice and treatment of evidence were reached from the level of data collection through that of interpretation of analytic results. We assessed each required judgment as being adequately conservative if it provided a broad band of allowance for error in a direction opposite to that where the apparent conclusion about the issues at hand pointed.

CHAPTER 4

CASUALTY RATE PATTERNS

We have found that a great deal of confusion about casualty rates can be cleared up by looking at available casualty data in terms of the rather straightforward concept described graphically in Figure 4-1. The illustration represents a notional picture of the key features of modern ground combat as they relate to casualty rates.

The pattern is based on the view that casualty rates occur in three key dimensions: echelon (or size of force), time, and sector(s). The premise is that knowing all three-dimensional aspects associated with any given casualty rate will help us to group sets of like rates appropriately, to distinguish them from other sets of unlike rates, and thus to make appropriate rate comparisons.

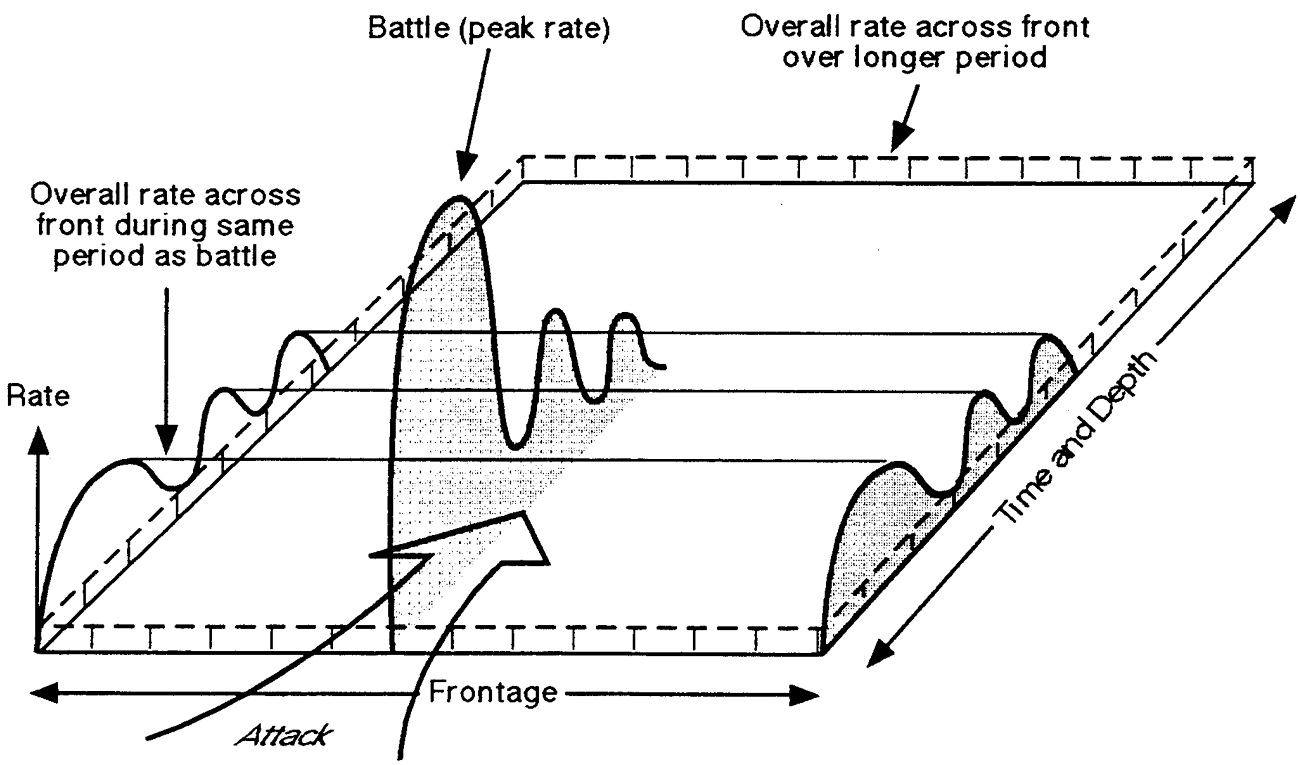

FIG. 4-1. NOTIONAL CASUALTY RATE PATTERN

Use of the pattern to group sets of casualty rates helps ensure that the most general aspects of the forces and actions giving rise to the casualty rates are systematically associated with those casualty rates.

Most past attention to casualty rates has focused on either rates for battles or rates representing more aggregated experience. Analysis and data collection have tended to conform to this two-part approach: describing rates for one or more particular battles, or describing rates aggregated for long time periods (for example, by week or month or year) and for unit types (such as armor versus infantry, or by named organization). Most effort has focused on battle rates, usually with the assumption that rates for all combat actions are directly comparable. The interest in battles easily combines with the assumption of direct comparability; consequently, rates sustained in short, sharp clashes between tactical units have often been paired with rates sustained by far larger forces over much longer time periods.

The confusion about casualty rates is to a significant degree a result of this mismatching of combat phenomena. What are clearly like types of experiences with respect to certain qualities are by no means alike with respect to other considerations. Two battles may be quite alike as regards their being armor-heavy offensive actions, yet fundamentally different in one's being an armor battalion attack over a 3-day period while the other is an offensive conducted by an armor-heavy corps over a month.

In general, attempts to group rates by sets of common features have focused on functional characteristics of the actions or actors as common denominators (offense versus defense, light versus heavy forces, etc.). While obviously useful and appropriate for many purposes, other possible foundations for similarity or dissimilarity among the phenomena that give rise to casualty rates have usually been overlooked.

The notional pattern suggests that a key foundation for distinguishing among ground forces casualty rate experiences is found by simply combining the quantitative factors of force size (echelon) and time with the qualitative factor of sector type.

The notional pattern represents any given frontage, whether it be one of an army group or one of a single division. The pattern is based on several related observations. First, for any active frontage there will be one or more sectors along the front where casualty rates are highest. This sector (or sectors) marks the principal area(s) where one opponent attacks the other. To the flanks of this sector will be areas of lower rates. Second, no matter whether one looks at the attack sector(s) or at the flank sectors, casualty rates will vary over time. Taking both points together, then, there will be *pulses* of rates evident on two axes, along the front and over time. The fact of pulses indicates a corresponding fact of some degree of *variability* in rates. This variability will also exist across the front and over time. Third, the characteristics of these pulses and variation of rates will differ across the several echelons. A single division's pulses and rate variation should look quite different from those of an army group or those of a battalion.

We find that the use of this notional framework of casualty rate patterns, while appropriate across the full range of combat, is especially helpful at the higher echelons. There, the particulars of the combat vary so often and greatly (for example, as to what units are on the offensive or defensive on any given day, much less over the longer term) that only a comprehensive framework will capture their overall play. A comprehensive framework permits focus on either low-level tactical events or on the higher-level operations of which the tactical events are parts, or on both. Keeping the whole and its parts in view simultaneously prevents mistaking one for the other and makes possible a fuller, more accurate description of each.

Only such a perspective can properly guide both data assemblage and analysis of casualty rate experience. It enforces the linking of the theater's many and varied combat actions (battles and other) over all portions of the time line and across the full front. It requires that the details that go to form higher-level rates or aggregated rates be seen in their own particular places within that larger picture.

The notional pattern suggests that casualty rates will necessarily exhibit pulses and variability in both horizontal dimensions, and that these will also vary by echelon. What it cannot provide are the details that give measure to the magnitudes and durations of casualty rate pulses, to their frequency over time and across the front, to the degree of their variability over time, or to the relationship of rates between the echelons. For these specifics, the empirical data themselves must be consulted.

CHAPTER 5

THE EMPIRICAL DATA

This chapter describes the empirical databases developed for this study. Unless otherwise indicated, these data were developed from original official archival records.

NEED FOR EMPIRICAL DATA

At the onset of this study, we found what might be called disarray in the general area of available data on casualty rates. Far too often, studies of the subject were grounded not in empirical evidence, but in analyses of casualty data generated by either mathematical models or other studies. Several sources of empirical data existed, but they were either incompatible or incapable of providing the perspective needed.

Some sources focused on data for particular battles, while others only captured highly aggregated data. Some focused on pre-twentieth century data, others only on particular wars in the twentieth century. Nearly all used different definitions of casualties or strength, or provided no definitions. Some gave casualty figures without providing the relevant strengths at all, regardless of differing possible strength definitions. There was a host of particular mentions of casualties or casualty rates, in history or other books, with no sources referenced, and often only in qualitative terms. Even some of the better databases provided no sources. Further, only the better collections provided any sense of the time over which the cited casualties or casualty rates occurred – but the time periods differed considerably.

More immediately, however, we faced the fact that none of the databases available – whatever their strengths or shortcomings – addressed today's planners' needs. Those needs revolve – most clearly for U.S. and senior NATO commands, but ultimately for all NATO nations along the Central Front – around understanding how casualty rates behave in a theater-level conflict. The need is to relate rates at different echelons (corps to an army group, for example) and rates at different points along the front. The need, also, is to make sense of all such relationships in terms of time – Is the measure of interest each day's rate, or an average rate? Is the overall period of concern a short one, or one lasting many weeks or months? In terms of combat requirements – hence casualty assessments – such distinctions are critical.

GENERAL CRITERIA FOR SELECTING EMPIRICAL DATA

A set of data was needed that met several criteria. First, the data should be capable of addressing the study's principal analytic requirement: establishing whether ranges of casualty rates could be identified that could be reliably associated with broadly defined scenarios for a theater-level force set in Europe. As a minimum, the data should depict the experience of large forces across broad fronts over significant periods of time, not just experiences of single, intense tactical settings.

Second, the data should be drawn from actual operations (rather than hypothesized or generated data from whatever source) and must reflect those operations accurately (that is, show results of actual units engaged over the actual times involved – preferably, daily – rather than aggregations of results).

Third, the data should be consistent in terms of straightforward definitions of the types and sizes of forces and the types of casualties represented. It was decided that tolerances on what qualified as fitting the types of data could not be so restrictive as to exclude useful data or sources (such as data from different Services, eras, or nations). The definitions that originally governed the data collection of the different Services or eras or nations would be accepted, with appropriate recognition of differences so analysis would not be confused by results arising only out of definitional distinctions.

Fourth, the data should be drawn mainly (even exclusively, where possible) from official archival records. Casualty data abound in the combat literature. But they lack consistency in definitions of force size and counts of casualties, and are mostly mute as to time represented and sources.

Fifth, the full set of collected data should represent not only broad-front/long-term operations, but operations of different scales at different echelons in the same era and (as much as possible) from different eras.

Only such a comprehensive foundation could provide insight into the range of possible casualty rates and patterns adequate to support the intended analysis.

EMPIRICAL DATABASES DEVELOPED

1941 to 1945

- U.S. 12th Army Group
- U.K. 21st Army Group
- The German Army
- U.S. Divisions, Italy
- Battles

Post-1945

- U.S. Army, Korea*
- Middle East (1967, 1973)*
- National Training Center

Derived Databases

- Selected WWII Divisions, U.S. Western Front (from 12th Army Group)
- Selected WWII Battalions, Allied (from Battles)
- Selected WWII Divisions, German Eastern Front (from The German Army)
- Selected Middle East Divisions (from Middle East)

****NOTE***: These databases were taken directly from the work of Frank A. Reister (Korea) and Trevor N. Dupuy (Middle East), with no amendments made by LMI except as to form.

DESCRIPTIONS OF EMPIRICAL DATABASES

U.S. 12th Army Group

This database represents a force that evolved over some 6 months from one to four field armies. The force grew from eight to over fifty divisions, and from four to twelve corps. The data begin on 15 June 1944 and (with three minor and one major data gaps) cover each day through 30 April 1945. The data gaps include three 1- day gaps (16 June, and 3 and 6 July) and one 7-week gap (11 August through 30 September). The available data include 266 days, or roughly 9 months, of combat operations.

Though the database is entitled the 12th Army Group, in fact it covers the main American force on the continent in Northwest Europe during the stated period. That force was the U.S. First Army for the period 6 June through the end of July 1944, when the 12th Army Group came into being with the activation of the U.S. Third Army. By 1 October 1944, the U.S. 9th Army had been activated, and the database includes the data for the 1st, 3rd, and 9th Armies as of that date. (The data for 1-10 August cover only the 1st Army, not the 3rd Army.) The U.S. 15th Army was activated several months later. All armies' data are included in the database, but the 15th Army is excluded from the data analyzed as it engaged in combat operations only late in the war.

The data cover every division, corps, army, and (from 1 October onward) the army group for each day. They include authorized and assigned strengths, numbers of casualties (recorded in the categories of killed, wounded, and missing/captured), and daily organization (the assignments of divisions to higher echelons, of corps to armies, and so on). The records distinguish between authorized and assigned strength as of 29 October 1944, and before that cite assigned strength only.

The data distinguish personnel assigned to the line divisions from personnel assigned to higher echelons (corps/army/army group). At those higher echelons, the data also distinguish between personnel assigned to headquarters and logistics support functions and personnel performing combat missions (artillery, tank destroyer, etc.) Though these latter data describe the overall daily strength and casualty numbers of "combat" personnel, such personnel are not identified by assignment to particular units or unit types. The data also do not reveal even roughly how many of these higher echelon combat personnel were attached daily in support of particular line divisions, although such attachment was the standard procedure.

We decided to exclude higher echelon personnel from any calculation of casualty rates, even though these higher echelon personnel in fact closely supported divisions. A rate that included higher echelon personnel would not be as directly comparable to the rates projected for today's divisions (which exclude corps and higher personnel) as would the actual rate for the divisions themselves. Moreover, analysis of the rate of casualties for higher echelon combat personnel indicates a rate considerably lower than that for the line divisions directly. Addition of the casualties and strengths of these higher echelon combat personnel to those of the line divisions, given their relatively lower rates, would have the effect of masking the accurate division-level casualty rates.

The 12th Army Group data were found in G-1 Daily Summaries archived at the U.S. Federal Records Center, Suitland, Maryland, and at the U.S. National Archives in Washington, D.C. Other attempts to find records at the army, corps, and division levels have located only some such records, and often the records have significant gaps. Thus, they do not provide either the coverage or consistency required to meet this study's intent, though such records were used as one check of the reliability of the army group records' numbers.

The army group daily summaries recorded the strengths and casualties of the overall command and its subordinate commands (down to division level) as reported by those commands on a daily basis. The commands reported what they believed their strengths and casualties were, in the sense of what personnel were under their control or had been lost each day. As such, the casualty figures include all wounded-in-action as long as they were removed from a command's control during a day. Wounded-in-action figures therefore include both hospital admissions and some (probably significant) portion of the "carded for record only" number (i.e., that portion not returned to unit control during the day in question). The missing-in-action (and captured) figures were counted the same way – that is, the command counted those missing or captured who were not otherwise accounted for – with the fact some might return a few days later not affecting the daily recorded numbers. Personnel replacements plus any returns to duty (from the hospital system or from those formerly missing/captured) were included in the recorded daily strengths (though usually not separately listed).

The accuracy or reliability of the 12th Army Group records was checked in several ways. It was noted in other official reports after the war, first, that the set of G-1 Daily Summary casualty numbers differed less than 5 percent from the final figures recorded by the Machine Record Units (MRU) reports after the war. Our own review of the two types of records showed that such differences as often reflected higher as lower casualty numbers.

Second, the figures were compared to other figures taken from lower level (army, corps, and division) records. This comparison found, again, that the army group figures were within remarkably close tolerances of those from other sources – and, again, as often included higher recorded casualty figures as lower.

Lower echelon records appear generally to agree with army group counts of cumulative casualty numbers over a period, though they also sometimes portray the daily counts differently. These differences in count do not alter the fact of daily rate variability, or the kinds of daily rate magnitudes or rate variability seen.

This sometimes altered distribution of daily rates in some lower echelon records was considered a minor disagreement with the main database, for two reasons.

Records of this type from different sources almost always disagree on many daily particulars, given recording delays and different recording practices; unless the cumulative difference is significant, the daily differences are not critical obstacles to understanding casualty patterns. We found no differences in the cumulative numbers that were significant – even when a lower echelon record showed hundreds fewer or more casualties, the time period of the count was so large (usually at least 2 weeks) that the possible impact on actual daily rate calculations was not large. In any case, however, the study's analysis was designed so as not to depend on casualty figures being "perfectly correct" for particular days or time periods. The study instead focuses on measures of rate magnitude and variability of rates regardless of precisely when they might have occurred. Nevertheless, the agreement described in the following paragraph between division casualty rates and division locations on operations maps was helpful in building confidence in the general agreement of the army group's recorded figures and actual events on the ground.

Another check on the army group records' reliability compared their recorded casualty rate fluctuation for particular divisions to the tactical situation of those divisions as shown on daily maps of the operational area. The maps were the collected set of General Bradley's daily situation maps, prepared in most cases by his G-3 staff (in a few cases by the G-2 staff). The match between the G-1 casualty figures and the maps was remarkably close. For example, rates usually ascended and declined in close accord (usually on the day in question or within 1 day) with the map-recorded movement of the divisions by day either into or away from action on the front line.

Finally, we compared cumulative casualty numbers for certain divisions during specified periods (battles) with casualty numbers identified for those same units and times by the Army's medical planning ("MEDPLN") study in the early 1970s. Perfect matches of the two data sets were not expected, since the MEDPLN numbers were drawn from medical records originally maintained only on a weekly basis. The MEDPLN study team could only estimate how many of the casualties that had been recorded for a unit during a given week might have occurred during the particular cited operation. Despite the inevitable mismatches between such data sources, the 12th Army Group records consistently indicated rates as high as, or higher than, those in the MEDPLN data.

We identified the 12th Army Group records as a desirable potential database (given our study's theater focus and analytic design). The records were then collected by Data Memory Systems, Inc., (DMSI), and recorded and collated by LMI for analysis.

U.K. 21st Army Group

Data for the United Kingdom's 21st Army Group cover the British (and Canadian and associated) divisions that comprised the Group over the period from 11 June 1944 through 19 January 1945, roughly 7 months of combat. The data permit a view of the force's daily casualty experience similar to that available through the U.S. 12th Army Group database, with two major exceptions. First, some days of data are missing – occasional, to be sure, but enough to preclude a look at the nearly continuous casualty rate data stream possible with the 12th Army Group data. Second, the data do not include division strengths, which are necessary for determining casualty rates. To overcome the latter deficiency required that a method be devised to estimate division strengths based on battalion strengths (which were often provided); nevertheless, this did not prove adequate to ensure more than a reasonable range of a division's possible daily strengths.

The British figures were taken from corps and army records at the Public Records Office in London, and from 21st Army Group records on file at the U.S. National Archives in Washington, D.C. The records were identified and collected by DMSI and turned over to us for recording, collation, and analysis. DMSI also provided the algorithm for estimating division strength based on battalion strength, a method we later supplemented by directly comparing the actual numbers of British casualties sustained by each division each day to the numbers sustained by U.S. divisions whose strengths were known (and whose authorized, or "establishment," strengths and assigned strengths were generally lower).

U.S. Divisions, Italy

The database covers each American division active in the Italian campaign from 9 September 1943 through 31 May 1945. The data include all casualties (killed, wounded, missing/captured) by day for each division.

There are two shortcomings. First, the division strengths are not provided. Thus, as in the case of the U.S. 21st Army Group, a range of likely strengths was established for our analysis. We determined those strengths by using data (both for these particular divisions and for these types of divisions during this period) from other official sources. Second, the data provide no daily assignments of divisions to higher echelon organizations.

These data from the Italian campaign, however, contain a unique feature not available in any of the other databases: the daily numbers of wounded are distinguished into "light" and "seriously" wounded categories. (These data can be compared, with appropriate allowances for definitional differences, to the proportions of "Carded for Record Only" (CRO) and "Wounded Admissions" in the Korean War database, and to other contemporary data (such as data from Israel) that reflect at least aggregate proportions of similarly distinguished categories of wounded personnel.)

These data were found by LMI in official MRU records located in the files of the Army's Office of the Chief of Military History in Washington, D.C.

The German Army

This database contains the casualty records of more than 270 German divisions covering the period June 1941 through spring 1945. The divisions are grouped by army (5 panzer armies and 4 infantry armies) and often by corps.

The data include, by division, the numbers of casualties (killed, wounded, missing) sustained during blocks of time. These time periods are usually 10 days (or 11 for the last trimester of a 31-day month, or 8 or 9 for the last trimester of February). In a few cases, the time period is for a lesser or greater number of days.[1]

Ascertaining unit strengths introduced complications because the records containing casualty numbers only sometimes contained unit strengths. We followed the rule that only official records would be used as sources. [Anecdotal references to

[1]A very small portion of the database – with records of 37 divisions – does contain some periods with the division's actual daily casualty numbers. These periods of daily numbers represent only these divisions' peak casualty experiences, that is, only periods during which notably high casualties were observed for these divisions. Periods of low or no daily casualties, preceding and following these identifiably high periods, were not recorded due to staffing constraints. The recorded division periods vary in length, with 53 covering 10 or more days each and another 30 covering fewer than 10 days each. The number of division days thus recorded totals 885. The records for these divisions were the only German records found citing daily casualty numbers. They contain no evidence of unusual rates.

"actual" strengths – for example, in various histories – were found to be unreliable and almost always ill-defined in terms of identifying unit particulars, time (duration) of the stated strength assessment, or other necessary information.]

The database lists actual division strengths wherever this information is available. It is available relatively often for heavy (panzer and panzer grenadier) and elite (SS) divisions from the spring of 1943 onward. That strength is taken directly from the records containing the division's monthly casualty numbers. These strength numbers are the particular division's actual assigned strength as of the first day of the month, and the number is treated as the unit's average strength throughout that month. If these data were not available, a several-tiered method was adopted to identify a likely strength. The method sought the best available official evidence of strength; if the best information was not available, we used the next best that was available. The chain of official evidence begins with sources that state a particular division's actual strength for a particular time, proceeds to sources that state the actual strength of like-kind units in the same time period, to sources that state the actual strength of like-kind units during a longer time period, to sources that state the authorized strength (as opposed to the Table of Organization and Equipment [TO&E] strength) of a certain kind of unit during the same time period, and finally to sources that state only TO&E strength of a certain kind of unit during a longer time period. In every case where the actual assigned strength for a particular unit for a precise month was not available, the method averaged the strengths of all records (in the particular tier of records used) stating strengths for units of that type during the relevant time period.

Most of the data were found in army, corps, and divisional records at the Militaerarchiv in Freiburg, Federal Republic of Germany. Other significant data were found in Inspector General of Panzer Troops and Army Surgeon General records. Other German records searched both at Freiburg and at the U.S. National Archives did not provide significant additional data.

Battles

This database focuses on World War II battles. It was constructed primarily to depict the relative daily casualty rate experiences of several echelons of units (especially division, regiment, and battalion) in major, intense actions. It is comprised of 26 battles involving 72 divisions, and provides casualty data covering

386 division days, 468 regimental/brigade days, and 531 battalion days. The data include daily strengths and total battle casualties (mostly by day, but in certain regiment and battalion cases by daily average). The data also depict daily organization (assignments of subunits to parent units).

The battles were chosen mostly to represent major confrontations between conventional forces set in Northwest Europe and Italy (and, in four cases, forces in the North African theater of operations). The battles were selected to try to represent the general types of battles, and roughly the same kinds of units, as might be expected in a future conflict in Europe.

The database also includes four major amphibious operations in the European and Mediterranean theaters and four Pacific island operations. The Pacific operations represent combat of the grinding attrition sort (Iwo Jima) and combat of the sort judged probably more similar to certain potential future amphibious scenarios (because the landing force faces a heavy counterattack) and to the situations in the European landings.

Two reasons led us to decide to represent only the Allied side in each battle. First, the official daily German and Japanese data for these particular actions are not readily available; in at least several cases, they apparently do not exist. More important, the main purpose of the database is to reveal the relative casualty experience of different echelons in particular "hot spots," usually along larger fronts which are otherwise covered by the more comprehensive databases – notably, by the 12th or 21st Army Group databases. This purpose was believed best met with data from official records, even if only one opponent could be represented.

The data were extracted, in nearly all cases, from archived unit records. These records range from those for the particular units involved, to more inclusive records at corps or army level. The battles were identified as desirable for analysis by both LMI and DMSI, while the data were collected, collated, recorded, and checked by DMSI.

U.S. Army, Korea

These data show the Army's experience in the Korean War. The data are grouped into 85 operations (plus summary data covering longer periods). The data provide the actual numbers of casualties [categorized by total number hit, with that number then broken down into numbers of killed, wounded admissions, and "CRO"], but exclude any casualties that were missing or captured. Strengths are the average strengths of the overall number of units (divisions, regiments, etc.) participating during the operation in question.

The data include battle casualty rates that are based on the number of combat days during the period in question (whether that number is equivalent to the full time period covered or to only a portion of it). That is, the rates are not calculated to indicate a rate that includes noncombat days.

The database's author, Frank A. Reister, used official Army data from both the personnel and medical channels and, interestingly, grouped them into a number of perspectives. The 85 different operations are arranged by both particular battles and larger operations, by general (e.g., offensive versus defensive) posture, and by varying periods of time along the type of defensive lines peculiar to that war. The database also shows the 85 operations simultaneously from several organizational perspectives: combat divisions (and independent regimental combat teams); regiments within those divisions; division rear echelon; and several particular kinds of units (tank battalions, division artillery, division engineers, and medical battalions).

Middle East

We know of no casualty data that meet our data selection criteria and that were officially released by the various participants in the Middle East conflicts. The only set of data on the Middle East conflicts that meets many key criteria is that developed by Trevor N. Dupuy as part of his Land Warfare Database.

These data were apparently gleaned in the course of extensive interviews (supported by an unknown collection of documentation) with many high ranking and other knowledgeable participants from all sides in these conflicts.

The data published on these conflicts by Dupuy, and provided to the U.S. Army, are far more extensive than that portion we used in this study. We extracted data related directly to casualty numbers and strengths and to the parameters of most interest (echelon, time, and posture of the participating forces).

The casualty data are provided by battle or engagement and thus represent a single kind of sector (the attack sector). Casualties listed are total battle casualties, that is, single numbers for each side covering all battle losses for that side during a battle (without regard to particular day of incidence). Strength figures are calculated using criteria long established by Dupuy and related to the number of participants on each side subject to becoming battle casualties. The strength is the starting strength for each side at the battle's commencement, and does not count replacements or returnees.

We focused on the 1967 and 1973 Middle East conflicts (although Dupuy also has data on battles in the 1948, 1956, and 1982 conflicts). The 1967 and 1973 episodes were selected as best representing the substantial confrontations between the kinds and sizes of conventional forces and over the time periods appropriate for this study.

National Training Center

We collected casualty data for more than 300 U.S. Army battalion level engagements that occurred at the Army's National Training Center (NTC) from 1985 through 1988. The database is a sample of 139 of those engagements. The sample was chosen to be balanced as to unit type (armored versus mechanized battalions)[2] and unit posture (attack versus defense) and, as much as possible, as to unit equipage ("modernized" versus "nonmodernized" major systems).

The personnel casualty figures are those figures recorded by Army officials to account for total unit casualties during each engagement. The casualty figures are provided for each battalion engagement in that unit's paper record "Take Home Package."

Strength figures are usually not provided for individual battalions in these Take Home Packages. The only practicable method to extract usable strength figures – the method suggested by knowledgeable Army sources connected with the NTC – is to review individual unit "After Action Review" video tapes which usually contain information about the unit's strength. This method, however, is so labor intensive and subject to turning up tapes with no locatable strength data that the review was limited to a sample number of taped reviews that Army officials suggested would reliably represent average unit strengths. We extracted the

[2]Each engaged unit is actually a "task force" organized around a mechanized or armored battalion base. Thus, the casualties and strengths reflect this task organization rather than some straight TO&E-type count.

strengths of some 30 battalions, about evenly divided as to unit type, using this method. The results were averaged by unit type so as to represent armored and mechanized battalion task force strengths. Such results were used whenever the Take Home Package failed to provide a particular unit's strength.

Selected World War II U.S. Divisions

The comparison of casualty rates in the Middle East with those of World War II required that we select an appropriate subset of the overall World War II data set. The subset was selected from the U.S. 12th Army Group database, using criteria described in detail in Chapter 10 and Appendix G. This process identified 122 one-division/ one-day casualty rate values.

Selected World War II Allied Battalions

The comparison of NTC and World War II casualty rates required that we select a subset of the overall World War II data set that was appropriate for the comparison. The subset was selected from the Battles database and includes both U.S. and British battalion data. The criteria for the selection are described in detail in Chapter 10 and Appendix G. This process identified 51 one-battalion/one-day casualty rate values. As also described in Chapter 10 and Appendix G, the comparison of NTC and World War II experience suggested that two further (nested) subsets of these values be identified; they numbered 38 and 33 values, respectively.

Selected World War II German Divisions

The U.S. 12th Army Group database is the best and most reliable set of data to support a full analysis of an operational-level theater force covering a broad front over a long period of time. However, the question arises whether this army group's experience may be said, even with appropriate qualifications, to be representative of casualty experience in that war. The German Army faced a unique and powerful enemy in the Soviet Union on the Eastern Front – an enemy using operational methods and operating on scales not matched by those on the Western Front. It was necessary to find out whether evidence from the German experience tended to confirm (with whatever qualifications), or to deny, the representativeness of the 12th Army Group experience.

This data subset was drawn from The German Army database. Twelve major operations along the Eastern Front were identified to be of interest by the Soviet

Army Studies Office (SASO) at Ft. Leavenworth. Casualty data for German divisions that participated in these operations were extracted whenever available in The German Army database.

These division data, which as described above only reflect blocks of time (usually 10-day segments), were then compared by SASO individually with daily situation maps and battle accounts showing the experience of the individual divisions in each operation. Professional judgment was used to break the 10-day block casualty numbers, where possible, into smaller increments (usually two, in a few instances three, for each 10-day period) to reflect the tactical situation experienced by the division during those shorter periods. The 10-day casualty numbers were then allocated by their probable proportions within the smaller periods, again based on SASO's professional judgment of the divisions' evolving situations. These smaller time increments were also identified in terms of the type of sector and posture (as well as terrain) the unit occupied.

Finally, the strength figure provided in the database for each division was reduced by the amount of the losses imputed to have been sustained in each of the smaller time increments, to reflect more closely than is possible in the original database the strength decrements likely sustained by the division during the 10-day periods. These final strength figures were also compared, when possible given other official strength data known to SASO (that is, in the cases of some of the more famous division experiences), with these other official records to ensure the division strengths during the operations reached as low as the lowest recorded figure (except in one case of a notable division experience, where the judgment was that LMI's data on losses, hence the appropriate strength decrement, were more accurate than those in the other available source).

These casualty figures are discussed in Chapter 9 and compared with rates for U.S. divisions in the 12th Army Group database.

Selected Middle East Divisions

The comparison of Middle East and World War II casualty rates required that a subset of the Middle East data be selected that was suitable for the comparison. The criteria for the selection are described in detail in Chapter 10 and Appendix G. This process identified 18 Israeli and 16 Arab one-division/one-day casualty rate values, for a total of 34 values.

CHAPTER 6

PULSES AND VARIABILITY

Our research confirms the general notion about modern ground forces combat casualty rates suggested in Figure 4-1. We find that the fundamental elements of these patterns are daily rate pulses and significant rate variability over time. This chapter describes generally how daily pulses and variability must be viewed by echelon and time and across a front.[1] Chapter 7 then provides several quantitative measures of casualty rate characteristics.

FINDING 1: CASUALTY RATES EXHIBIT PULSES AND VARIABILITY

Finding 1(A): Pulses and Variability Occur by Echelon and Time

The best way to begin to understand the patterns in casualty rates is simply to view a set of daily rates over time. Figures 6-1, 6-2, and 6-3 show sample daily rates sustained at the division, corps, and army echelons, respectively, in a theater-level force over 9 months of combat.

The two aspects of pattern that stand out immediately are the fact of casualty rate pulses and the fact of high variability in daily casualty rates. Real combat data show daily rate pulses that vary in magnitude quite dramatically over time.

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[1]The data we use in this chapter and the next to illustrate the details of casualty rate pulses and variability are drawn exclusively from the 12th Army Group database, which alone among the databases affords the amount of daily data in unbroken time streams to support the analysis. Extensive study of all the other databases confirms the facts of daily rate pulses and variability, but the other data lack either the detail or the unbroken continuity in time needed to fully measure these pulse and variability phenomena quantitatively. The other World War II Western databases (the U.K. 21st Army Group, U.S. Divisions in Italy, and Battles) make abundantly clear that, in terms of casualty rates, those experiences are fully comprehended in that of the 12th Army Group. While the other World War II British and American data do not alter the insights into casualty rate patterns gained from the 12th Army Group data, German Eastern Front casualty rate data (outlined in Chapter 9 and Appendix C) definitely supplement our insights into both the magnitudes and the operational settings of certain casualty rate experiences. The German data also confirm that, when taken in proper context, the 12th Army Group data are representative of World War II rates generally.

Comparisons of casualty rates in operations subsequent to World War II with those in the operational settings of World War II are covered in Chapter 10.

30th U.S. Infantry Division

The division has some daily pulse rates that reach close to 50 battle casualties per 1000 strength per day. Most rates fall well below that. Other division rates, however, reach considerably higher levels (see Appendix B). While rates of 60, 80, and 100 are uncommon, especially given an army group of divisions on line (see discussion of ameliorative effects of large forces on casualty rates in the next chapter and Appendix G), they are not unheard of. Rates in excess of 100 are certainly rare, yet we see several examples reach to between 120 and 150, and in one disastrous case the daily rate hit 577 (the 106th Infantry Division).

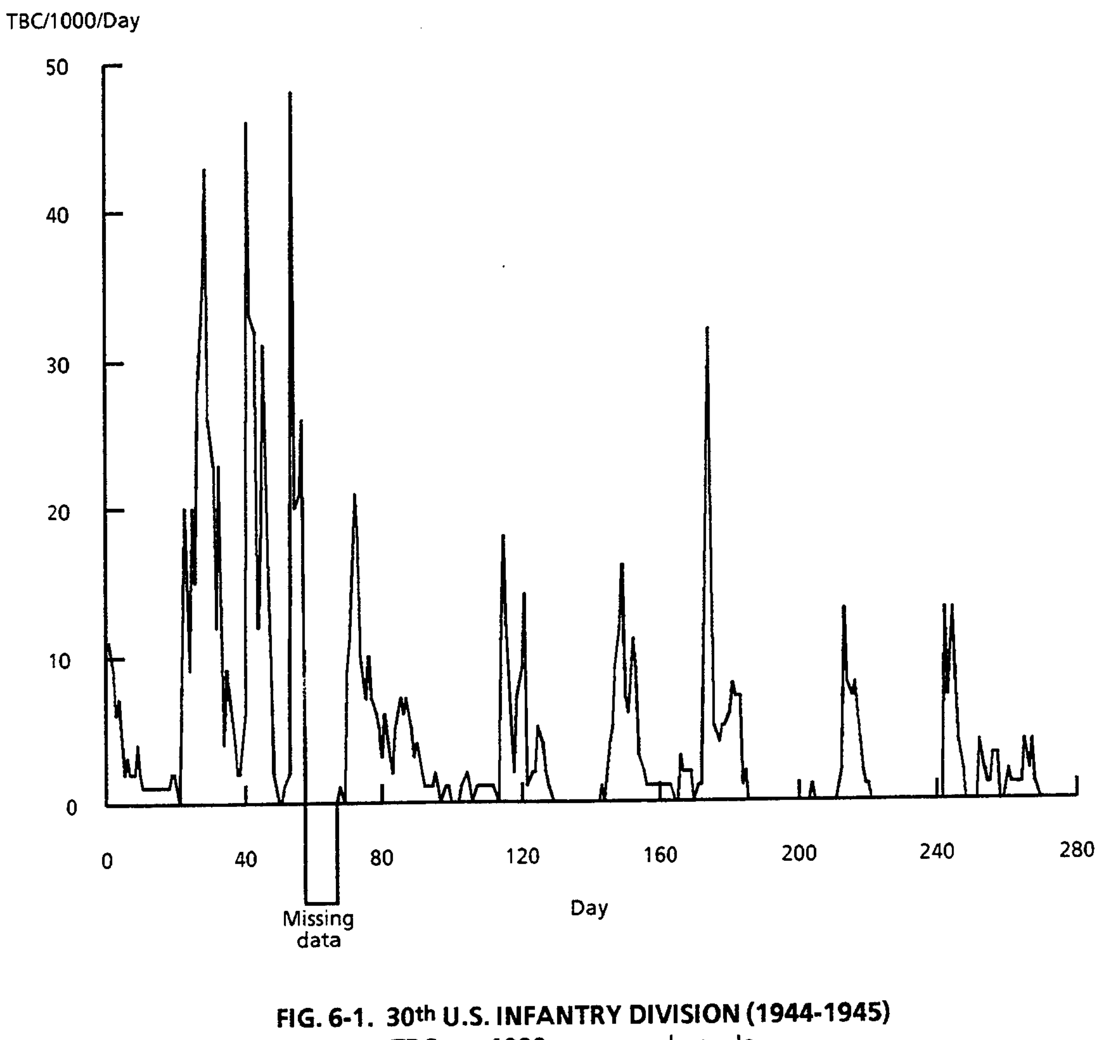

FIG. 6-1. 30th U.S. INFANTRY DIVISION (1944-1945)
TBC per 1000 personnel per day

The daily variability of casualty rates is perhaps even more dramatic than the magnitudes reached. Even in periods where single-day peaks reach toward 40 or 50, the rate will nearly always fall from that peak to something below 10 or even 5 within at most a few days. As shown in Chapter 7, when daily rates reach the higher levels, rates on closely succeeding days are dramatically lower.

VII U.S. Corps

Higher echelons exhibit lower casualty rates in general, though on particular days their rate may exceed particular lower echelon rates. The VII Corps rates reach toward 35 on a few days. Those are not the highest corps rates found (see Appendix B, especially for VIII Corps). They do, however, illustrate how the range of corps peak

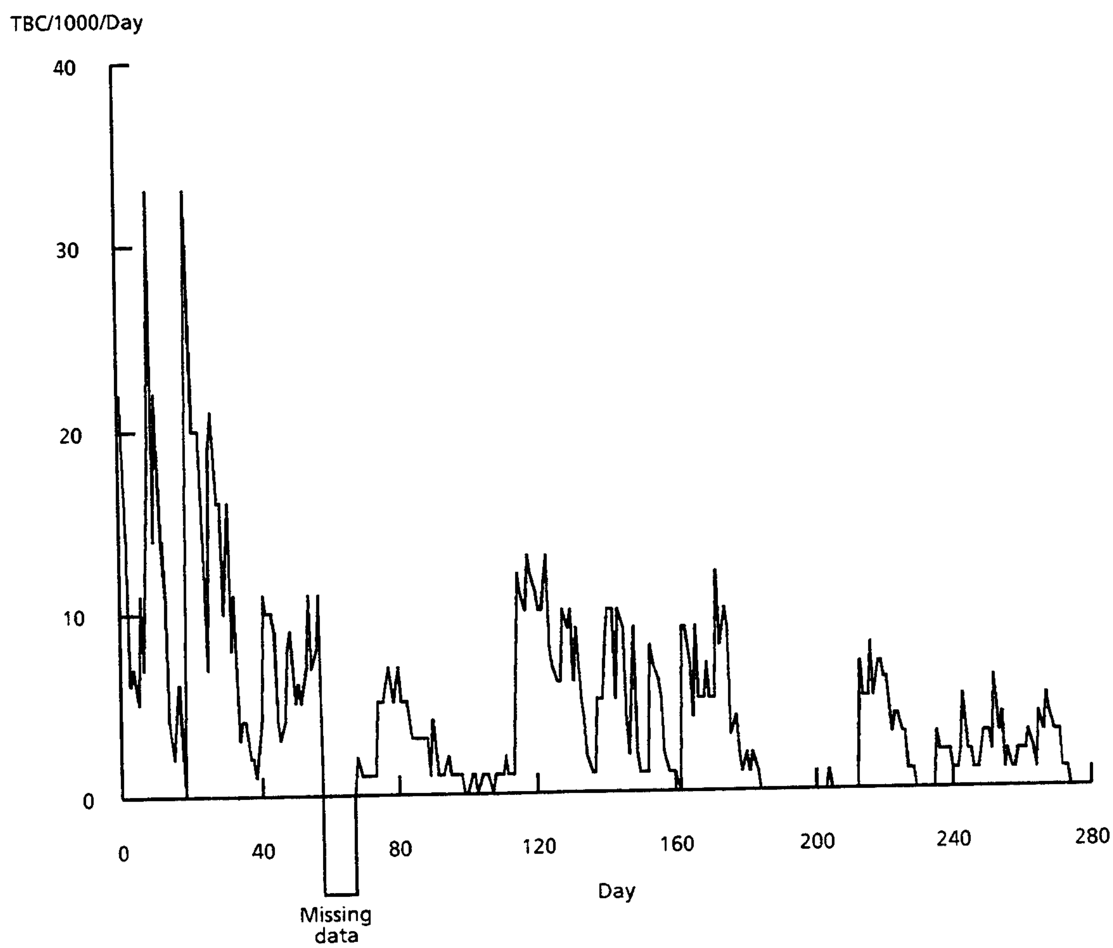

FIG. 6-2. VII U.S. CORPS (1944-1945)
TBC per 1000 division-level personnel per day

daily rates generally falls considerably below the range of peak rates for individual divisions. The variability of corps daily rates is also necessarily restricted when compared with that of individual divisions, since its range is constrained by the lower peak daily rates.

1st U.S. Army

At the army echelon, the set of daily rates shows even more restriction than at the corps level. However, at both the corps and army echelons, the variability of daily rates remains dramatic when viewed in terms of those echelons. The army's 10-day moving average of the daily rates highlights multi-day casualty rate pulse periods.

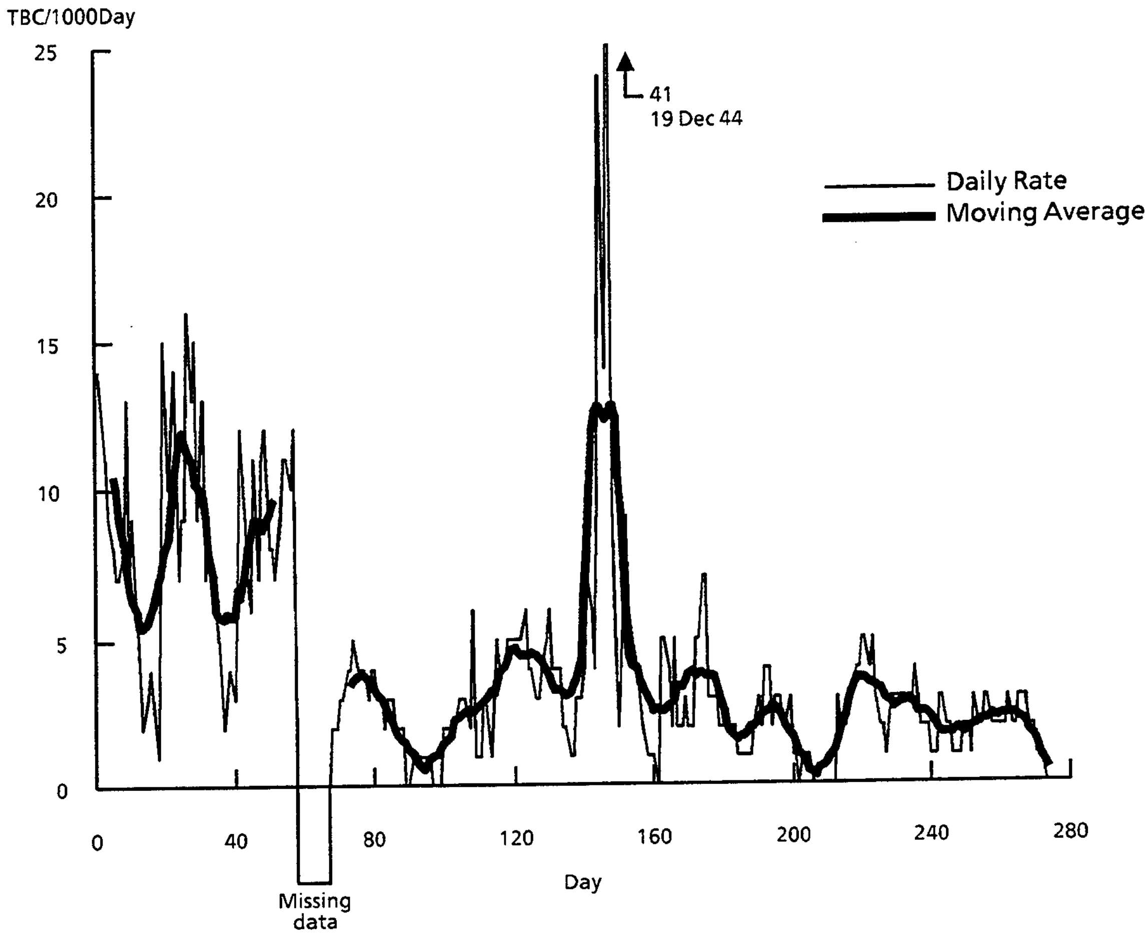

FIG. 6-3. 1st U.S. ARMY (1944-1945)
Daily and moving 10-Day average rates for TBC for division-level personnel

The more extensive the set of casualty rate experiences reviewed,[2] the stronger the impression of the nature of the rate patterns. For that reason, we provide time-series graphics showing the full set of division, corps, and army rates from the 12th Army Group in Appendix B.[3]

Findings 1(B): Pulses and Variability Occur Across a Front

Casualty rates pulsate and vary not only in time but also across a front. We found this to be the case when contrasting the attack sector to flank sectors and even within the attack sector itself. The focus of greatest daily combat intensity shifts often.

The phenomenon of shifting combat focus across a front is difficult to illustrate. Figure 6-4 depicts the daily casualty rates of front line divisions (that is, with any reserve divisions not shown) of the U.S. 1st Army during the first 5 days of the Battle of the Bulge. The sector shown is the German main attack sector, which focused on VIII Corps but also engaged a portion of V Corps. The graphs read from left to right across this portion of the front. The successive days are as marked.

This straight-line representation of course suffers from the fact that the actual line was not straight and steadily elongated as the "bulge" developed. In fact, several early German penetrations formed various finger-like extensions and small bulges, which as U.S. forces withdrew eventually joined into the famous "Bulge."

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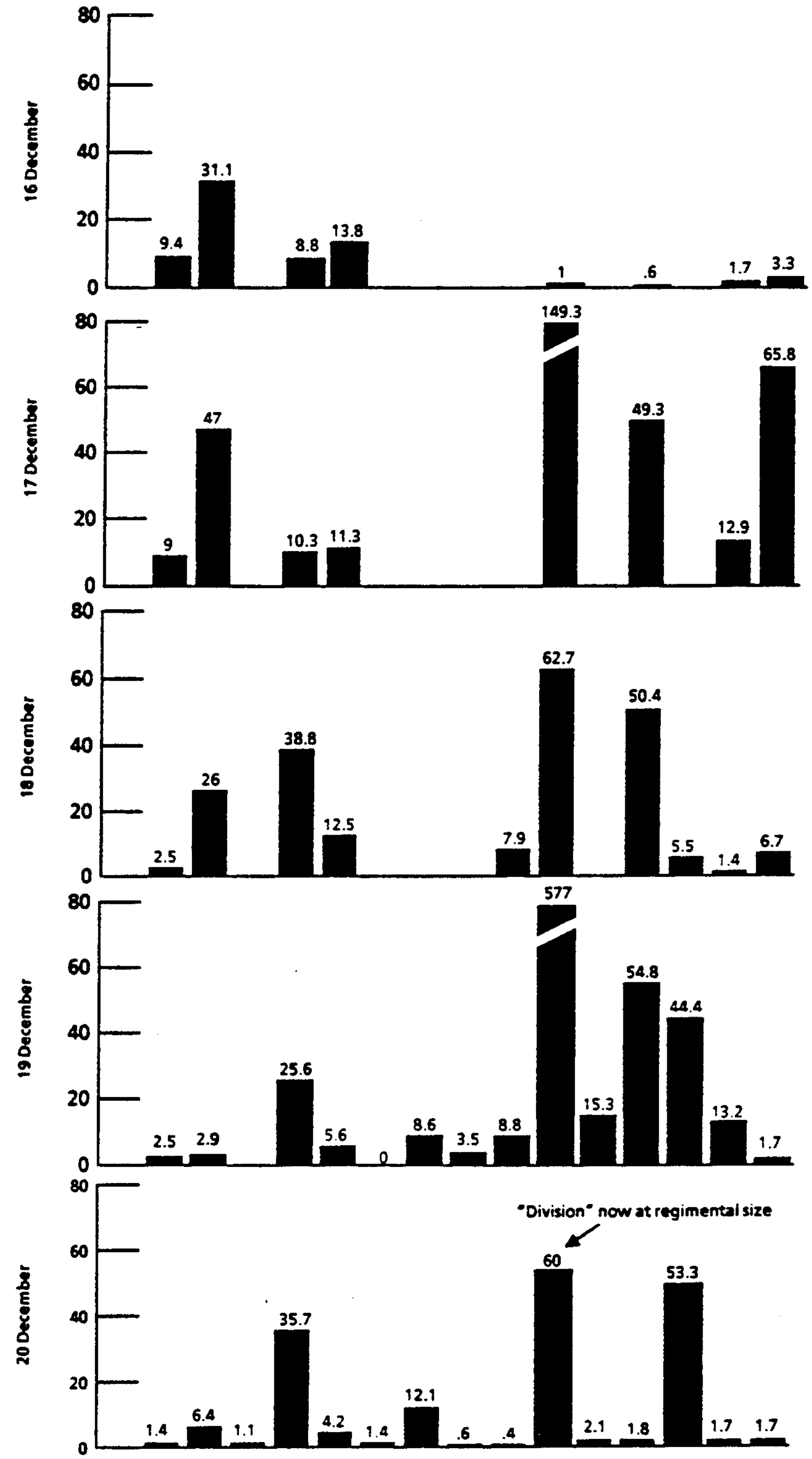
[2]We found one exception to this observation. One of the three U.S. Marine Corps divisions in the battle for Iwo Jima had periods of several days' length each where rates appeared relatively smooth for their magnitudes (between 10 and 30 per 1000 per day, with a few isolated higher pulses). The other two divisions showed more daily variability, but still not nearly as much as found with divisions elsewhere, including those we reviewed for the Pacific island battles of Saipan, Guam, and Bougainville.

[3]The daily rates shown for echelons above division – i.e., corps and army – are the mean rates for the line divisions comprising that higher echelon on those days. That is, the rate shown is the average rate for all the divisions assigned to or operating under that higher echelon organization; the rate does not include the casualty experience of "overhead" (command, administrative, logistics support, or nondivisional combat) personnel assigned or attached to that higher echelon organization. If that experience was included, the rates would be significantly lower.



Note: Each column represents one division. The divisions are shown as they were positioned along the front relative to each other day-by-day. No attempt has been made to represent the front's length precisely, or the exact portions of frontage occupied by each division. A division's position in line remains the same through the five graphs unless its position relative to other divisions changes.

FIG. 6-4. DAILY DIVISION RATES IN MAIN ATTACK SECTOR (TBC/1000/DAY)

A second view of pulses across a broader front may be seen in Figure 6-5. The perspective here is across the 12th Army Group's several corps for the full period of the first 10 days (16-25 December 1944) of the same "Bulge" campaign. Again, the straight-line representation cannot show how the front lengthened or how the corps

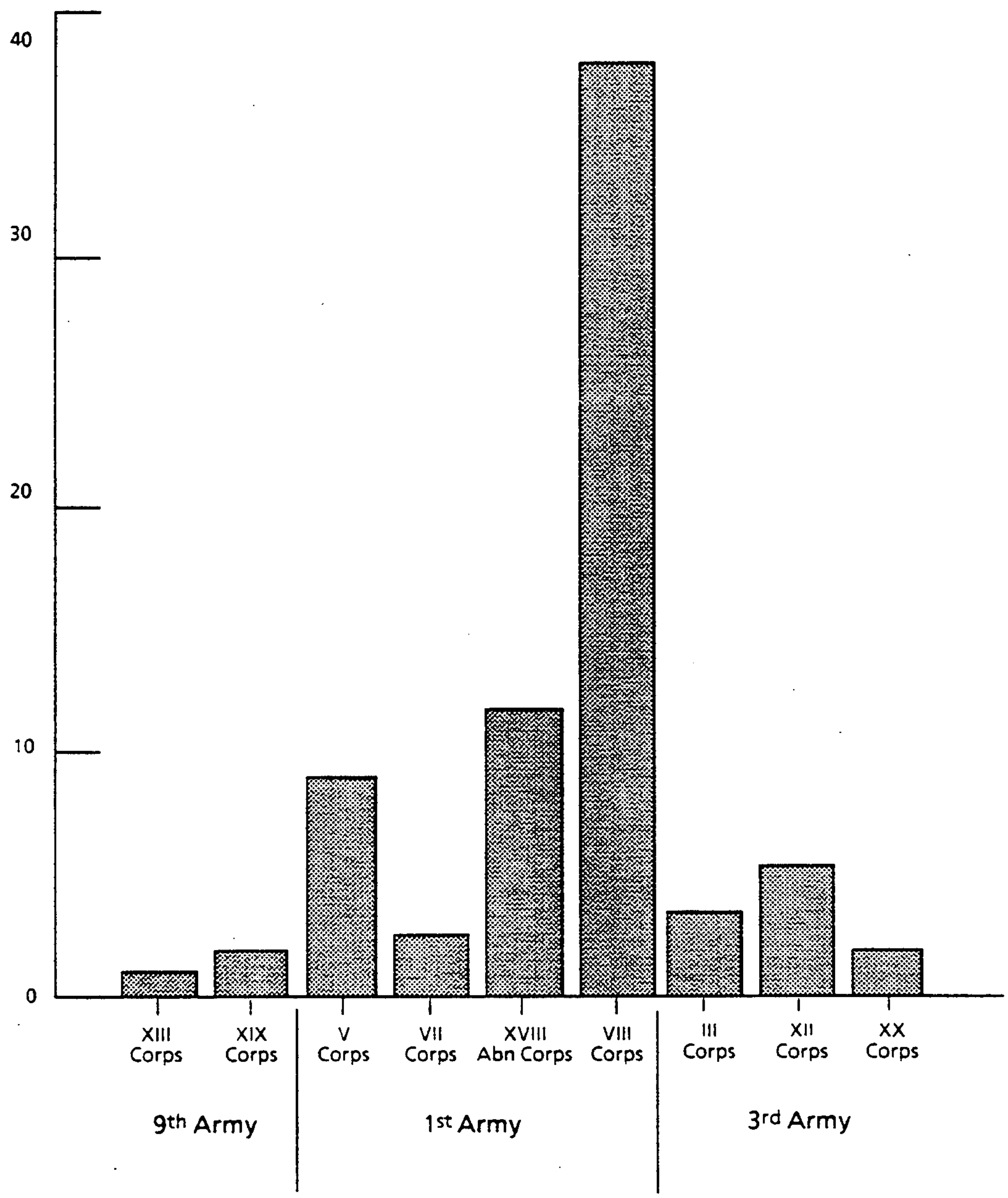


FIG. 6-5. CORPS 10-DAY CASUALTY RATES, 16-25 DECEMBER 1944 (TBC/1000/DAY)

in fact shifted both their relative positions and their Army attachments. Corps positions are shown as of 25 December. (We show VIII Corps as part of 1st Army because the bulk of the corp's casualties were taken during the first 5 days, before it was attached to 3rd Army.)

Summary

We have used two seemingly independent axes of interest (time and front) to represent aspects of real events as observed from two angles. We are unable to illustrate the truer representation of these events on a flat surface; it would combine these perspectives and reveal what may best be described as pockets of intense combat that endure for relatively short periods of time and shift about the force.

These pockets of intense combat denote locations in which one or both of the opponents is attacking or counterattacking. Thus, the portion of a force's front within which these pockets of intensity occur and shift reflects an attack sector. That sector might be a main attack sector, the flank of a main attack sector, a secondary attack sector, or any of a number of other designations that have been used to describe combat axes of different focus or purpose.

Our evidence shows that within any such sector the focus of greatest combat intensity, as indicated by casualty rate, will vary over time for a unit and shift between units with what may seem to some to be a surprising alacrity. Our research also indicates that these sectors themselves will shift over time. For example, within a few days a major attack sector may become a secondary attack sector or even a relatively quiet sector as the focus of the combat shifts elsewhere. This shifting was found to be the case both in the American experience on the Western Front (e.g., the Ardennes defensive) and in the German experience in major defensives along the Eastern Front (e.g., Kiev and Lvov-Sandomicrz).

CHAPTER 7

QUANTITATIVE CHARACTERISTICS OF CASUALTY RATE PATTERNS

It is possible to characterize the patterns of casualty rates by echelon, time, and sector. The keys to these characterizations are the daily rate pulses and their variability that underlie rate patterns. Both are dramatic, and they are related.

This chapter addresses three measures[1] of casualty rate behavior: (1) the relationship of pulse magnitude to pulse duration in time (Finding 2); (2) the relationship of the average (mean) casualty rate during a multi-day pulse to the variability of the component daily pulses during the time period (Finding 3); and (3) two views of rate phenomena that help explain the proportions of a large force that experience high casualty rates (Finding 4).

FINDING 2: AS CASUALTY RATES INCREASE, THEIR DURATION IN CONSECUTIVE DAYS DECREASES DRAMATICALLY

Understanding casualty rate phenomena depends on understanding that casualty rates are a measure of combat phenomena, and it is impossible to conceive of realistic combat circumstances in which fighting intensity simply persists at some level regardless of time. A primary question about casualty rate phenomena, then, is whether a relationship exists between how high a rate is and how long it may be expected to last.

Our approach to resolving this question was to consider the casualty rate experiences of each of the roughly 50 divisions represented in the 12th Army Group

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[1]We report here on measures of rate by time and echelon. Measurement of the behavior of rates across sectors and within sectors requires such an extensive and separate kind of effort from that needed to measure rates by time and echelon that it is necessary to combine the analysis of the empirical evidence of sector rate phenomena with analysis of the treatment of these phenomena in current rate projections. In our next report we will emphasize U.S. and German experiences in World War II across operational-level fronts in comparison with various (especially model) representations of casualty rates by sector in the current rate projection methodologies. However, Figures 6-4 and 6-5 in the last chapter provide an initial sense of the behavior of rates across sectors.

database. Our hypothesis was that the higher the rate, the shorter its duration in consecutive days.

Our first step was to define several classes of casualty rates. We defined the class intervals (shown in Figure 7-1) based on our general observation and sorting of rate magnitudes and frequencies. For each division, we counted the number of consecutive days the division's casualty rate fell into a given class (or some higher class) of rates before dropping to some class of rates below the class of interest.

Figure 7-1 shows the results. The highest rates – in the class of 20/1000/day and above – tended to last only a single day, or perhaps two. In one instance a rate above 20 lasted 8 days, and in another a rate above 10 lasted 13 days. These cases, however, were extraordinary. The weight of experience at these rates fell fully into considerably shorter time spans. As one moves to successively lower rate classes, the data show that the durations of rates gradually extend over greater numbers of consecutive days. We expected this trend. We did not expect the data to reveal a nearly classical negative exponential curve.

The message is unmistakable. As a casualty rate increases, its duration decreases – dramatically.

FINDING 3: DAILY RATE VARIATION INCREASES AS THE MEAN RATE OVER TIME INCREASES

The fundamental features of casualty rates – pulses and variability – naturally raise the question of whether a relationship exists between rate and variability that may be measured. Our approach to this question was to see what relationship exists between an echelon's rate over a given period and the variability of that echelon's daily rates during the period.

We keyed our measures to periods in which daily rate pulses tended to cluster, and were careful to look at periods defined by pulses of varying magnitudes. We refer to that clustering of a number of daily pulses in a distinct time period as a "multi-day pulse" or a "peak rate period." We chose 10 days as the time period. We looked at both offensive and defensive peak rate periods at each echelon, and at periods when units won and lost in each posture.

We chose a simple measure: relate the unit's average (mean) rate for the 10 days to the variability about the mean of the unit's actual daily rates during the

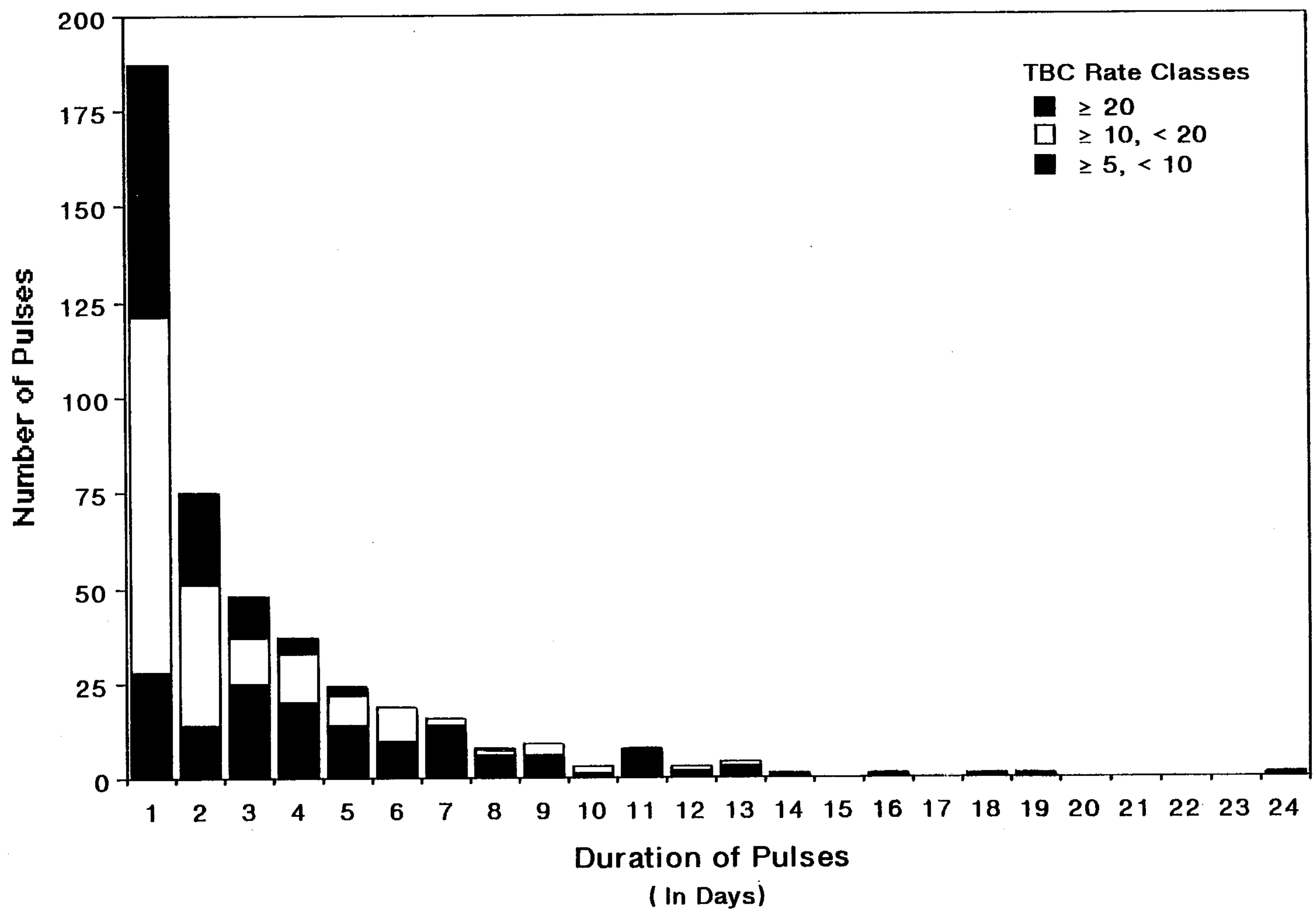

FIG. 7-1. DURATION OF DIVISION PULSES AT VARYING RATES

period. Thus, for example, a division's mean rate over a 10-day period is shown in relationship to the standard deviation of the division's 10 daily rates about that mean.

Figure 7-2 shows the results of 106 division casualty rate pulses of varying magnitudes taken from the full set of divisions in the 12th Army Group database. The number of pulses that could be so addressed was reduced mainly because, to ensure statistical correctness, we did not count any day as part of more than one pulse period. Given a 10-day measurement and the need to focus on pulses of different magnitudes, we had to ignore certain pulses.

Figure 7-2 shows the relationship between rate magnitude (mean) and variability (standard deviation) to be a relatively well-defined cone into which the varying mean rates and their associated degrees of variability fall. The cone thus defined helps us to evaluate whether a projected casualty rate – say, by a mathematical model representing a division – corresponds to casualty rate patterns demonstrated in actual combat.

For example, if we are given the division's projected mean casualty rate for a 10-day period, we may identify an appropriate range of values within which the variability of the division's daily rates should fall if the division's 10-day projected set of rates exhibits a realistic character.

Following this procedure, if we are given a division 10-day mean rate of 20, then according to Figure 7-2, we should expect to see a standard deviation (s) lying somewhere between about 7 and 28. Any value of s lying well within that range would be consistent with actual combat experience. A value of s on the edges of the range would be barely consistent with combat experience and would suggest other indicators are probably necessary to check the reasonableness of the division's rates. A value of s falling outside the range would be suspect – the farther outside, the less credible.[2]

[2]The figure shows 2 of the 106 cases where a division experience is outside the cone. In each case, the division experienced considerably more variability than was typical for its 10-day mean casualty rate. In no case does the variability fall below the cone. Of course, cases could reasonably fall below the cone (see Figure 7-3), but they would be quite rare, not typical.

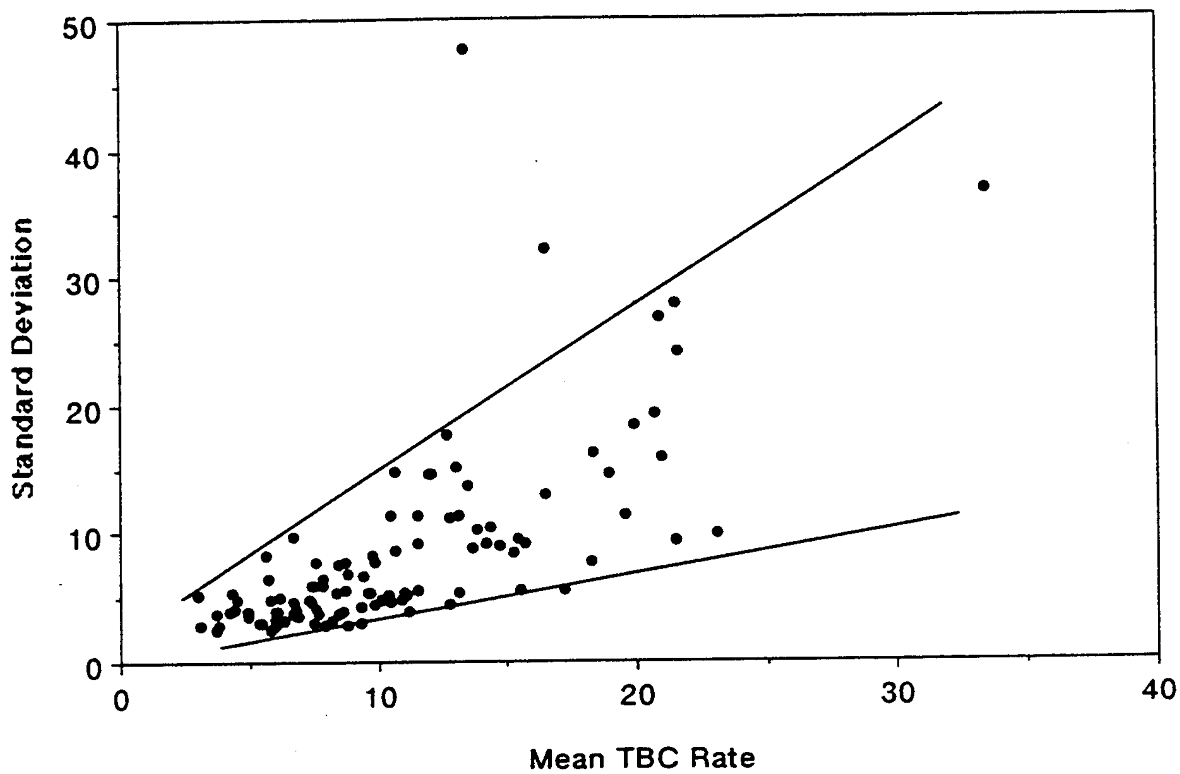

FIG. 7-2. MEAN AND STANDARD DEVIATION FOR 106 10-DAY DIVISION PULSES

It is also possible to combine the insights from this rate variability cone with insights from measures of rate-duration. Given that same 10-day mean rate for the division, it should be possible to identify a range between the peak single-day rates and the lowest single-day rates that would be highly probable if that division's mean rate were to show a variability and duration of rates akin to actual combat experience. In other words, while variability (measured by standard deviation) is fundamental, it is also possible to look for certain *shapes* in casualty rate curves. Rates do not typically swing back and forth with regularity about the mean; they swing by widely varying amounts.

The same procedures may be followed for corps and army casualty rate experiences. Significantly fewer data points are available, however, as one moves to higher echelons. Although less reliance might therefore be placed on such measuresat the higher echelons, their credibility is enhanced to the extent their character is well within expectations given the results of the larger division data set. Figures 7-3 and 7-4 show the results of this analysis for corps and armies, and those

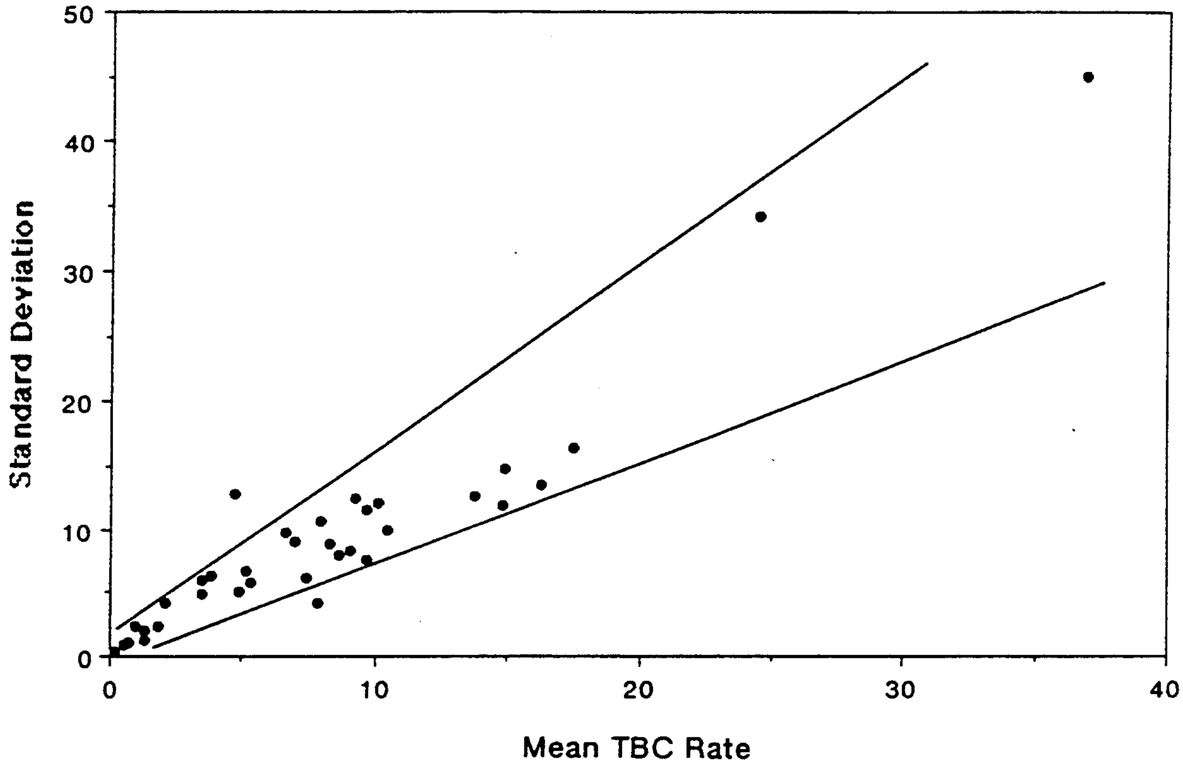

FIG. 7-3 MEAN AND STANDARD DEVIATION FOR 35 10-DAY CORPS PULSES

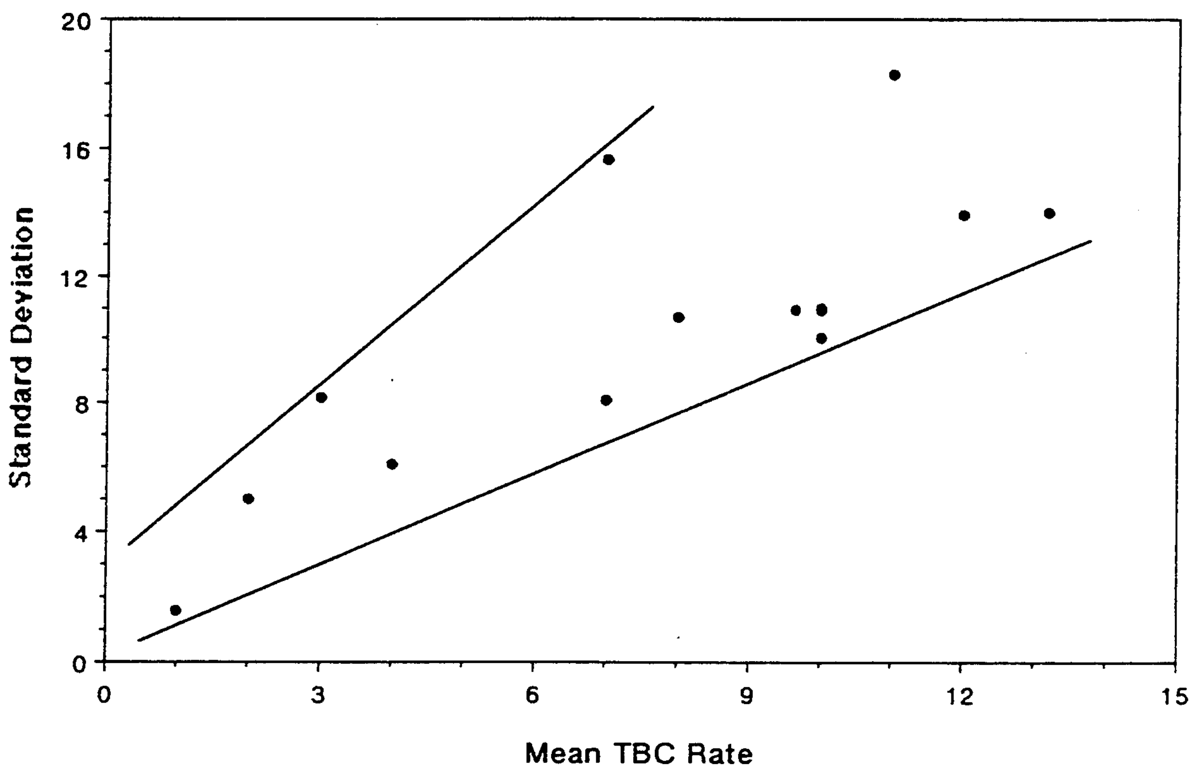

FIG. 7-4 MEAN AND STANDARD DEVIATION FOR 13 10-DAY ARMY PULSES

results match reasonable expectations. In particular, the relatively narrow cone of corps experiences indicates that the relationship between mean rate and daily rate vari-ability may be especially stable at the corps level.

FINDING 4. THE PROPORTIONS OF A LARGE FORCE THAT ARE INTENSIVELY ENGAGED REFLECT THE EFFECTS OF DAILY RATE PULSING AND VARIABILITY OVER TIME AND ACROSS THE FORCE

Pulses and variability are closely associated with an aspect of combat that long has been of central interest to military analysts: the proportion of a combat force that is heavily engaged at any given time.

We have seen that, for any given echelon, we must view the phenomenon of rate pulsing and variability from the simultaneous perspectives of time and frontage. The casualty experience of an army-size force, for example, will reflect the fact of pulsing and variability of its divisions' rates over time and across its front by day. Thus the proportion of the army-size force with high casualty rates tends not to be great either on any given day or over the longer period. This is so even though on any given day, and throughout the overall period in question, the rates for some divisions in the force may range from serious to catastrophic.

We display here two measures of this phenomenon of low proportions of forces intensively engaged. The first is a measure of the dispersion of rates, by day, across a force of at least army size. The second shows the frequency of the rates across the force – a count, by day, of the number of divisions in the force that fall into certain categories, or classes, of casualty rates.

Dispersion of Rates

Figures 7-5 and 7-6 provide a sense of the rates experienced on successive days at defined intervals of the force.

The method used to build Figures 7-5 and 7-6 is to rank-order by day the force's division casualty rates from highest to lowest, and then to display three of those rates for each day: the highest single division rate (i.e., the 100th percentile); the rate of that division at the 90th percentile of the rank-ordered force; and the median rate for the force.

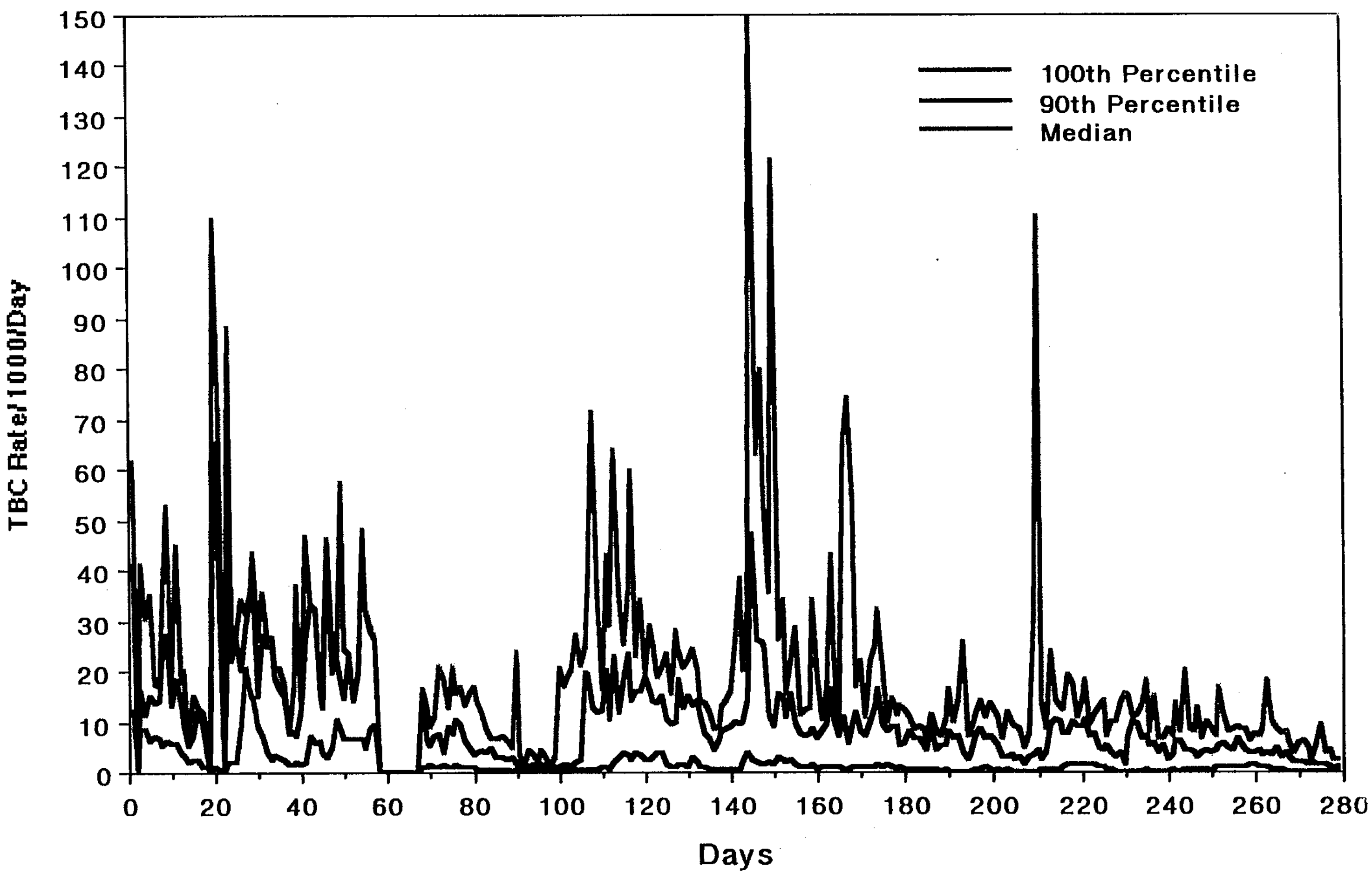

FIG. 7-5. THEATER FORCE DAILY CASUALTY EXPERIENCE

Division Rates at Selected Percentiles of Force

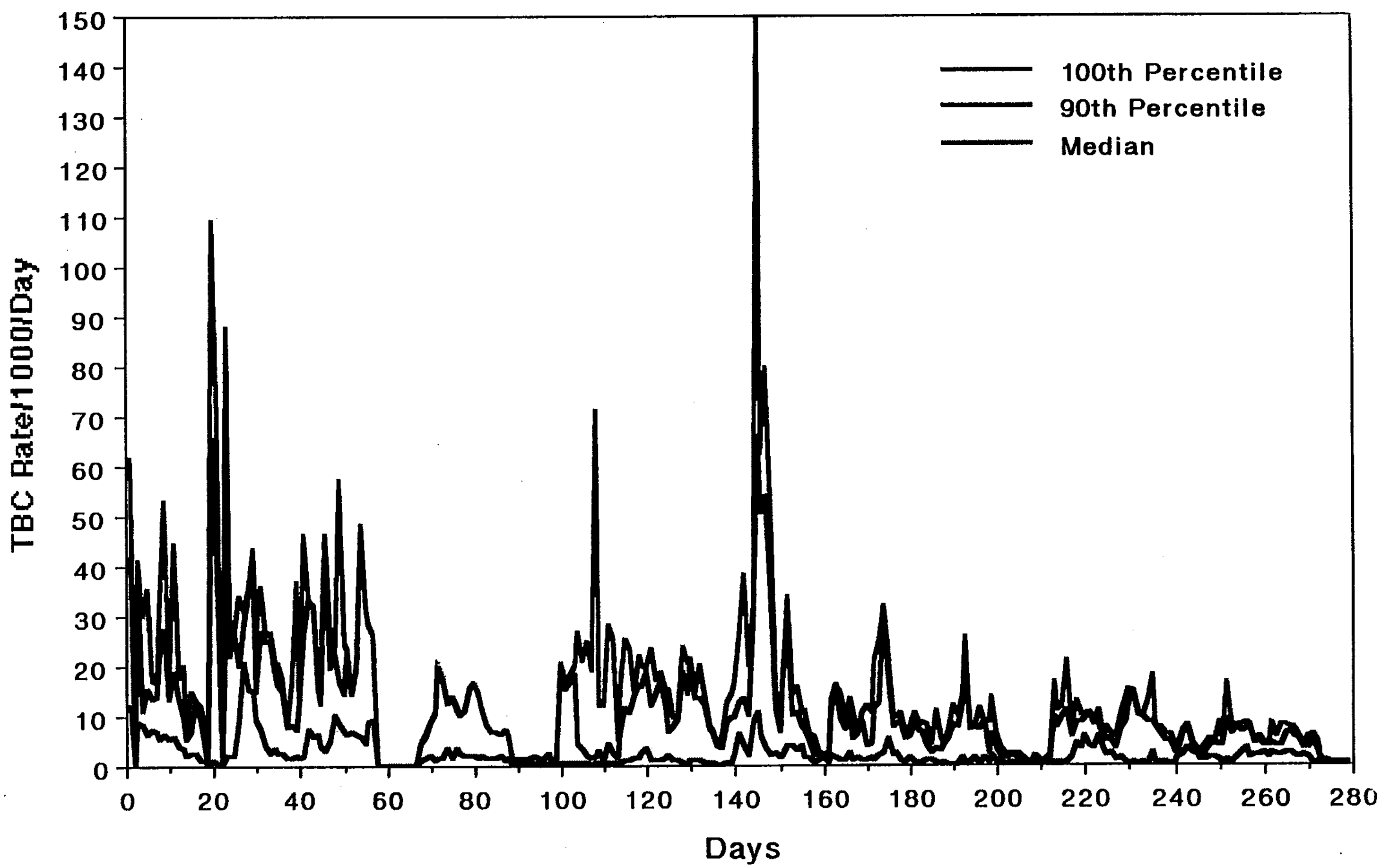

FIG. 7-6. FIRST U.S. ARMY DAILY CASUALTY EXPERIENCE
Divisiona Rates at Selected Percentiles of Force

Figure 7-5 represents the entire U.S. force on the ground in Europe under General Bradley's command.[3] [This force was comprised of one army (the First) until the data gap, and of three armies (the1st, 3rd, and 9th) for the rest of the time line.] Figure 7-6 represents only the 1st U.S. Army. (This force is identical, then, with that in Figure 7-5 during the Normandy period, before the data gap.)

Three observations are in order. First, Figure 7-5 shows that the peak rates across the full theater force (at the 100th percentile of the force) tend to be higher, for days with high rates, during the Central European period (after the data gap, and specifically in November to January from around the French-German border on into Germany) than during the Normandy period (before the gap).

Second, the dispersion of rates at the upper end of the rank-ordered rate spectrum was also greater during Central European fighting than during the fighting in Normandy. This greater dispersion in the Central European period is in part due to the size of the respective forces: the Normandy force was only one army, whereas the force in Central Europe was made up of three armies. The 90th percentile rate will likely be closer to the top rate in a smaller force than would be the case for a larger force. Figure 7-6 confirms the effect of force size on dispersion – when only one army is viewed, dispersion is less. But there also appear to be key operational reasons for the narrower dispersion of rates in the Normandy period, which are suggested in the third observation.

Finally, and perhaps most important, the median division casualty rate during the Normandy period is generally substantially higher both in absolute terms and relative to the daily top rates than during significant combat operations in Central Europe. Figure 7-5 shows this is clearly the case for the full force. Figure 7-6 shows it remains the case even when the force size is relatively constant. Two apparent exceptions in Figure 7-6 actually strengthen, we believe, the observation that Normandy median rates are higher than those in the Central European setting.

Figure 7-6 shows the First Army's median rate rises during the first few days of the Ardennes defensive to an absolute level comparable to that Army's median

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[3]U.S. divisions that were attached to General Montgomery's command are not included except for those in the 1st and 9th U.S. Armies during the Ardennes campaign and the 9th Army while it was under British command for some weeks thereafter. Furthermore, divisions with the 7th U.S. Army, which was assigned to the 6th Army Group, are not included.

during two of three peak rate periods of the Normandy experience. Likewise, the figure shows the First Army's median is higher, relative to the Army's peak rate, toward the end of the war than during the Normandy experience. However, this Army's maximum rate is so high during the early Ardennes defensive, and so low toward the war's end, that the two medians in question are put in a different perspective. The Ardennes median fails to rise high enough to correlate strongly with the high Normandy medians, while the late-war median is high only relative to generally very low maximum rates. The Normandy experience remains characterized by high medians relative to the experience in Central Europe.

These observations on median rates indicate the dispersion patterns in Figure 7-5 characterizing the Normandy and Central European experiences turn as much on operational differences between the two settings as on force size. The fact is that a greater proportion of the force in the Normandy setting is relatively heavily engaged on both bad and good days than of the force in the Central European setting.

The question is why was a greater proportion of the force heavily engaged in Normandy than in Central Europe. We offer two, overlapping possibilities. It seems evident, first, that differences in terrain played a key role. The terrain in Normandy was less susceptible than that in Central Europe to canalized operations. For example, the American sector of the Normandy lodgement offered little good tank country, hence was a poor environment for mobile operations (which tend to run along relatively narrow axes of advance and concentration). And the infamous "hedgerows," which occupied attackers' attention for a period, afforded defenders seemingly endless opportunity to fight efficient defenses along lines and then, when necessary, simply move lines rearward a short way. Defenses were able to frustrate attackers' efforts to concentrate with effect, which reduced attackers to pushing hard across the full front while looking for (and, as eventually happened, making) opportunities.

Terrain, however, may ultimately have played a lesser role in influencing the proportion of force intensively engaged than did a combination of straightforward operational and logistics factors. The full operational front during the Normandy period comprised only two Allied armies. By fall, the front had grown to occupy some seven Allied armies. The simple (but substantial) growth of force size and

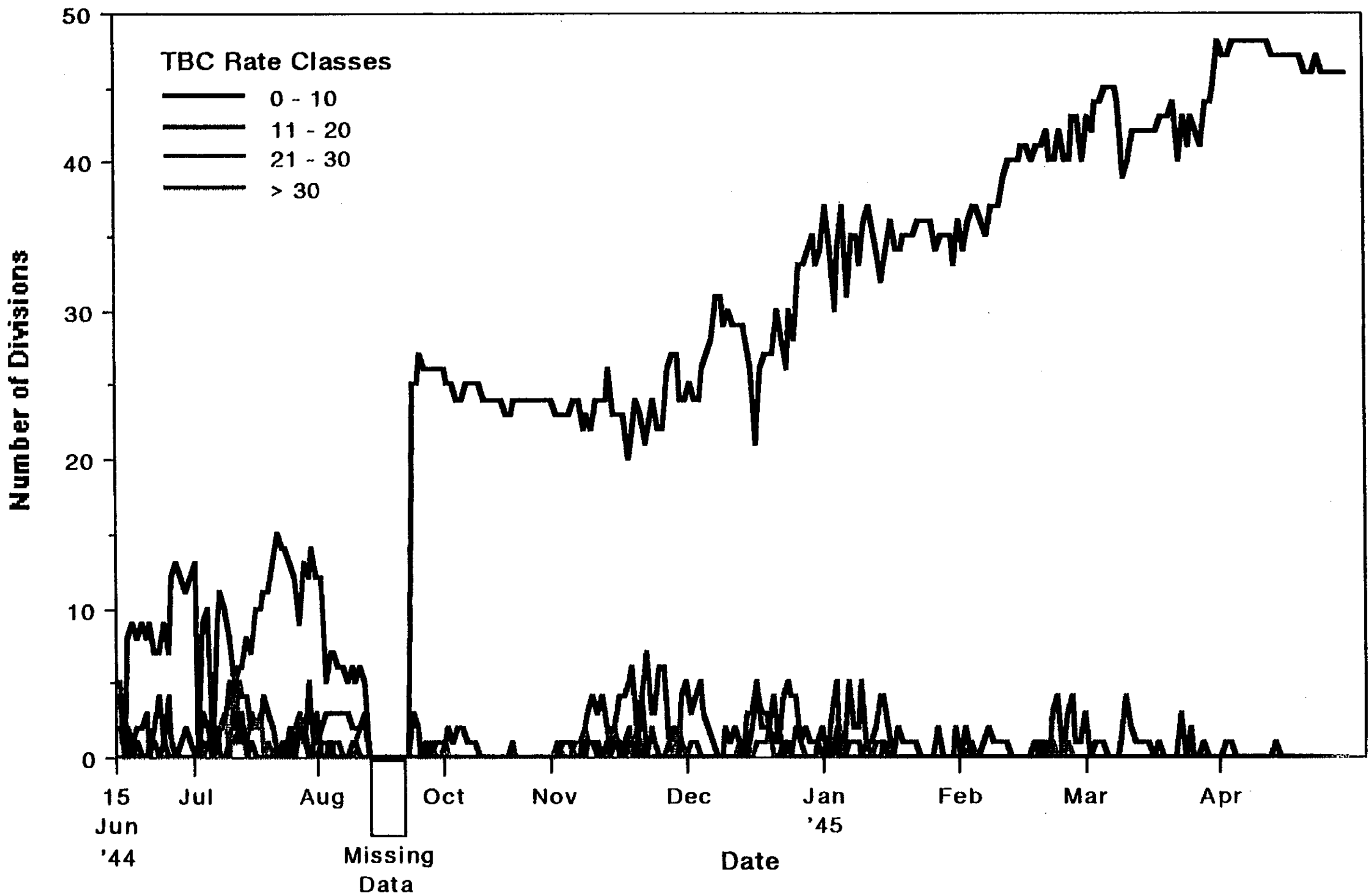

FIG. 7-7. THEATER FORCE DAILY CASUALTY EXPERIENCE

Number of Divisions in Rate Classes

broadening of frontage appears to introduce an operational-level condition in which the larger force focuses its effort in relatively narrower portions (sectors) of that larger frontage than appears true for forces sized to shorter operational frontages. The greater focus is commanded, we suspect, by both the greater complexity of the combat environment and, as part of that greater complexity, by disproportionately increased logistics burdens.

Frequency of Rates

A second way of portraying the proportion of the force that is heavily engaged is to show the number of divisions that, on any given day, fall into certain classes of casualty rates. Figure 7-7 displays the 12th Army Group data by daily count of divisions in classes of casualty rates. The first striking aspect of the graph is the relatively large number of divisions that have rates between 0 and 10 casualties per 1000 personnel per day. The numbers of divisions falling into the other three classes are more nearly alike than any is to that first, lowest class of rates.

The graph also suggests a more powerful observation. If one looks across the peaks of the three highest rate class counts, it appears that the highest division counts (or peaks) in each class suggest nearly straight lines across the graph. That is, the number of divisions in any of these higher rate classes tends not to exceed a certain count – no matter whether in Normandy or in Central European fighting, no matter whether on offense or defense, no matter what the size of the overall force. The point seems to be that regardless of the force size, posture, or setting, the absolute number of divisions that bore the heaviest casualty rates on days of heaviest combat did not fluctuate greatly.

Summary

Two points summarize this consideration of the proportion of an operational-level force heavily engaged. First, the heavily engaged proportion of such a force will be relatively small for any given day or period – though its distribution (dispersion of actual rates) will differ when force size and operating environment are as dissimilar as in Normandy and Central Europe. Second, an apparent corollary to the first consideration is that as the size of the operational-level force grows, the total number of divisions that experience high casualty rates on bad days will not grow appreciably, if at all, from the number in the smaller force.[4] The proportion of the overall theater force experiencing the highest rates will thus decline as the overall theater force grows.

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[4]Some observers have cited what they call a classic Soviet rule of thumb that for any *Front* – roughly 200 to 400 kilometers – the corridor or corridors of penetration, which will vary in width depending on several factors, would generally not exceed a total of some 20 to 40 kilometers. The overall penetration sector width will vary in response to the assessed correlation of forces, the desired superiority in the penetration sector, and situational factors. Once these factors are calculated, the overall sector width becomes well defined. The sector might then be subdivided into two or more narrower penetration sectors, but the overall width devoted to penetration will remain constant.

When one considers that the frontage of an attacking division cannot be compressed usefully below some practical limit, it becomes evident that any overall restriction on the width of the penetration sector(s) also places a limit on the number of divisions that can be usefully employed at any one time to penetrate.

Perhaps the Soviets, who are careful students of combat history, have observed that while a larger force permits longer duration of operations (e.g., intense operations in the penetration sector), it does not necessarily yield more short-term striking power in a given sector than a smaller force.

CHAPTER 8

MAJOR CONDITIONS ASSOCIATED WITH CASUALTY RATE PATTERNS

We have found strong evidence that certain key distinctions exist between casualty rates at the operational-level of war and those at the tactical level.[1] Some of these differences are associated directly with the level of war that forms the overall setting of the combat in question. Such differences mean that at least some observations that describe casualty rates accurately at one level of war are not accurate at the other level. Other differences are tied more specifically to the most general character of events along the front.

FINDING 5: THE CASUALTY RATE FOR AN ARMY OVER A 10-DAY PERIOD OF PEAK INTENSITY DOES NOT NECESSARILY SHOW DIFFERENCES ASSOCIATED WITH OFFENSIVE VERSUS DEFENSIVE POSTURES, OR WINNING VERSUS LOSING

Certain important analyses of casualty rates have shown that a unit on the defensive and losing will have a rate twice as high as a unit on the offensive and winning. We were initially puzzled, then, at the fact that the peak 10-day rates for armies in the U.S. 12th Army Group do not exhibit such differences, whether the army was on the defensive and losing or on the offensive and winning. Figure 8-1 shows the five highest 10-day peak rates for army-size forces in the 12th Army Group database.

The first four peak periods represent rates when the army was on the offensive and winning – in the sense at least that it maintained the initiative as it continued to

[1]It is impossible to draw a neat line differentiating tactical from operational-level actions. It would seem clear, however, that an army-size force of divisions (again, in the American usage of the mid-twentieth century) taken for 10 or more days is an operational level phenomenon, while a corps or division taken for 5 days or less is a tactical phenomenon. We do not address whether an army experience over 1 or 2 days may be considered a tactical one, or a division or corps experience of more than, say, 20 days might represent an operational-level event.

press toward its goals.[2] The last peak represents an army on the defensive and losing. It shows the 1st Army during the initial 10 days of its Ardennes defensive, that is, over the period the army was losing in any reasonable sense of the term, and before the German offensive was stemmed.

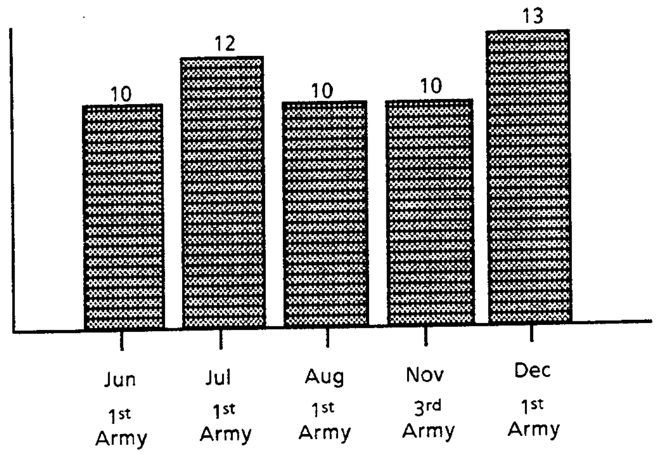

FIG. 8-1. ARMY PEAK 10-DAY (DAILY AVERAGE) CASUALTY RATES, 1944 (TBC/1000/DAY)

The set of five rates does not show a doubling of rates for an army on the defensive and losing versus an army winning an offensive. Instead, the one major and clear-cut instance of an army on the defensive and losing shows a 10-day rate that is only somewhat (about 20 percent) higher than the average rate across the other peaks.

On the other hand, our data on German experience for the Eastern Front reveals one 11-day period when a German army (comparably-sized to an American army) experienced a rate of almost 19 casualties per 1000 personnel per day. This is

[2]Defining winning and losing is notoriously difficult. An army-level force that continues to pursue its overall objective may well suffer serious reversals as it proceeds. These reversals may include outright tactical defeats, even though the overall force is only temporarily distracted in its longer term end. A 10-day time period may include many such "details" for a force as large as an army. Similarly, the force may include numerous tactical "wins" that are quite costly. An operational-level force over 10 or more days provides a mix of many of both cases. The overall force's casualty rate includes both kinds of events, plus spaces of lesser action along the front and over time.

clearly on the order of twice the rates seen by any such Allied force on the Western Front – and, as far as the data indicate, by any other German army on the Eastern Front. The German army in question, the First Panzer Army during the last 11 days of July 1944, was on the defensive and losing. That condition, however, describes the situation of many of the blocks of army-level data in the German database, only a handful of which equaled or even approached the range of peak rates shown for U.S. armies in Figure 8-1.

FINDING 6: CASUALTY RATES WILL REFLECT WHETHER FRONT REMAINS "CONTINUOUS" OR IS "DISRUPTED"

Our review of army 10-day peak casualty rates suggested that something else than an army's winning or losing posture must explain whether the army's 10-day rate approaches the level of 20 per 1000 personnel per day—the level (recalling Figure 1-1) now envisioned by certain U.S. Army estimates as a probable 10-day peak rate for a U.S. army-size force in a future European conflict. We found in the German experience on the Eastern Front what we believe is the key factor in such a 10-day army rate.[3] This factor is also suggested by the implications at the army level of the U.S. 106th Infantry Division's experience early in the Ardennes campaign. Our analysis focused on operational-level defensive settings.

We observed that a single, broad-scenario circumstance is of overriding importance to operational-level casualty rates. That circumstance is whether the defensive frontage either maintains its basic integrity or is instead fundamentally disrupted by enemy action.[4] The latter frontage will experience average casualty rates that are both markedly higher than the former and, in terms at least of certain continuous frontage situations, differently composed.

We will call "continuous" fronts those operational-level fronts that maintain their basic integrity when on the defensive. Maintaining integrity does not mean

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[3]We also discovered that the great majority of data that support the analyses cited above – which suggest a 2-to-1 ratio between the casualty rates of losing defenders and winning attackers – reflect only tactical actions. The data represent peak battle rates for tactical units over short periods of combat. About 80 percent of the actions since 1937 cited in the most recent of these analyses were battles lasting 3 days or less, and over 90 percent involved the tactical echelons of regiment, division, and corps.

[4]Comparing certain German and American data suggests that a similar dichotomy may apply to an attacking force as well. An attacker's rate may reflect more whether cohesion is basically maintained during the attack than whether the attack succeeds or fails.

there are not some gaps produced and even penetrations, or other signs of porousness that develop. A continuous front may very well experience a considerable withdrawal of lines rearward from the initial line of defense, as happened to the U.S. 1st Army at the Battle of the Bulge. This kind of defensive front is called "continuous" because, no matter any shortrun gaps or other failings or even substantial falling back, the attacking enemy is not able to exploit such weaknesses before they are somehow made good.

We will call "disrupted" fronts those operational-level fronts that experience a sudden, quick loss of some significant portion – a major "chunk," as it were – of the defensive line to enemy offensive action. This might include wholesale loss of units (more likely, major portions of them) or their effective loss by means of shattering or bypassing actions. In such cases the overall army-level defense's integrity is at least temporarily disrupted. The attacker gains the ability to conduct maneuver within the defender's original lines with substantial (possibly corps-level) forces. The defender will probably combine efforts, as seen in the Ardennes defensive, to fall back to some point where defensive capability is restored with efforts to counterattack – until the attacker's momentum is contained. The defender might also emphasize the more active of these measures.[5]

No Western Allied army experienced a disrupted front in the years 1944-1945. The U.S. First Army came closest, with the sudden loss on 19 December 1944 of the entire forward defensive positions of a full infantry division (when the two forward-deployed regiments and accompanying troops surrendered after being surrounded and cut off). Yet the Germans could not fully exploit the gap thus created before their progress was contained by a number of events, including the withdrawal of some U.S. divisions as others arrived and increased defensive resistance or counterattacked. The front was seriously breached, but its integrity was maintained and full exploitation was blocked as the line reformed farther back.

Three considerations lead us to believe the 1st Army's experience may define the demarcation along the casualty rate spectrum for operational-level forces

[5]The "AirLand Battle" doctrine generally describes defender activity in a continuous-front situation, which is the situation assumed in the NATO policy of "forward defense." The doctrine prescribes the kinds of aggressive activities that will unbalance the attack and retain combat initiative. The doctrine also applies to defender efforts should the front be disrupted, and may be taken as perhaps an improved way (especially in the absence of operational depth behind the front) to limit the danger and damage to defender forces inherent in such a situation.

between rates associated with continuous fronts and rates possible on disrupted fronts. First, the only occurrence of an army 10-day rate that significantly exceeds the level defined by the six rates in Figure 8-1 is the case just cited of the German First Panzer Army. That rate of 19/1000/day for 11 days occurred in the Soviet Lvov-Sandomicrz operation, which represented the second phase of their Belorussian campaign (termed by the Germans The Destruction of Army Group Center). These operations disrupted the German front in a manner simply not experienced by Allied forces in the West.[6]

Second, the range of rates evidently associated with a continuous front in a worst-case scenario is suggested in analysis of the U.S. 1st Army's 10-day rate during the Ardennes defensive in light of both the recorded and reconstructed experiences of the 106th Infantry Division.[7] When we analyze the effect on the army 10-day rate of moving from the 106th Infantry Division's recorded rate on 19 December to its more probable rate on that day, we see the army rate move from 10 to 13/1000/day. The higher rate is the correct one for this continuous-front episode. However, we can also at least imagine that if the 106th had not lost its two regiments, the recorded rate of 10/1000/day would be the more correct one. The latter (recorded) rate is perfectly compatible with the other four peak rates. The former (truer) rate remains well within the province of other peak rate experienced by U.S. Armies. We know the Battle of the Bulge represents, from a defender's perspective, a potentially worst-case scenario that in fact never reached to the worst-case outcome itself. Considering the U.S. 1st Army's rate from the two perspectives (afforded by the two rates) suggests a range of possible rates for a front in a potentially worst-case

[6] Figures were not found for the German armies (as wholes) that suffered the Belorussian offensive. It is probable they are also in the vicinity of 20/1000/day. We do have records on particular divisions in the heart of that operation's major attack sector (e.g., the German 197th Infantry Division). Their casualty rates did not exceed (and in fact, were not as high as) rates of some divisions in the Lvov-Sandomicrz operation.

[7] We have found it useful to maintain the perspectives afforded by both the division's actually recorded data and the reconstructed data. The recorded data indicates what the division understood its casualties to be, assuming as it did that the two regiments were not altogether lost. Retaining both the recorded and the reconstructed rates provides useful perspectives on: (1) the character of a defender division's rate in a severe attack that does not, however, disrupt the tactical front (the recorded division rate); (2) the character of a defender division's rate sustained at the attacker's intended point of disruption when the attack is at least tactically successful at that point; (3) a range of army-level rates (discussed above in text) that distinguishes a continuous-front defensive situation that is stressful (using the division's recorded rate) from one that is worst-case (using the division's reconstructed rate); and (4) an army-level casualty rate (using the division's reconstructed rate) where a line might be drawn, also discussed in the text, between a worst-case continuous-front rate and a rate reflecting a disrupted front situation.

scenario that, however, maintains its fundamental integrity. Thus, we have a perspective on a worst-case continuous-front situation.

Finally, we attempted to test this possibility hypothetically of a demarcation point along the spectrum of army 10-day casualty rates between a worst-case continuous front and a disrupted front. We assumed the second consideration is true – that the more correct rate for the Bulge represents something of a limit to the rates associated with continuous fronts. We then postulated, using actual data, the effect on the army 10-day rate of opening a truly substantial portion of the army's front at a time when the Germans might successfully have exploited the much broader gap thus created. This calculation was done by postulating that the 106th's experience (notably the loss of its two regiments and the entire frontage they occupied) was also the experience of the division located next to it in the center of the attack sector. On the right was the 28th Infantry Division; on the left, the 99th Infantry Division.

We first substituted the rates of the 106th in the campaign's first 5 days for the first 5 days of the 28th's experience, 16 to 20 December 1944.[8] Next, we performed the same substitution with the 99th Infantry Division, leaving the 28th's own experience intact. Finally, we assumed that both the 28th and 99th Divisions suffered the 106th's experience in the campaign's first 5 days.

The effect of these three hypothetical excursions was to raise the army 10-day rate respectively, to: 16/1000/day (28th Infantry Division added); 17/1000/day (99th Infantry Division added); 20/1000/day (both divisions added). These rates agreed closely with our one actual piece of evidence (from the Eastern Front) of an army 11-day rate from a disrupted front of 18.6/1000/day. Given the agreement, and aware of the kind of gaps the postulated events would have opened, we find that the number 20/1000/day has more than incidental interest for army-size forces.

An army 10-day rate of 20/1000/day falls well into the range of rates that define a disrupted front. That range would seem to start at about 16 – 17/1000/day and reach some 20/1000/day. Rates in this range suggest a situation of staggering loss for an organization of army size over a period of 10 days. Certainly, such rates might go even higher (as we could imagine for other operations in the East for which

[8]The 28th Infantry Division transferred to 3rd Army on 21 December 1944. We did not extend our hypothetical excursions to that Army.

insufficient army-level data exist). But all such possibilities also clearly point away from rates associated with continuous fronts.

Assuming a continuous front, the evidence is that 10-day peak rates for an army-size force will not exceed about 13/1000/day, and will most often fall significantly lower. The rate of 13/1000/day appears to represent the near-breaking point of a continuous front. If a disrupted front is assumed, the rate may well reach 16 – 20/1000/day (or even somewhat higher). We find it possible that the rate for a disrupted front would fall into the area of those rates associated with continuous fronts. But the opposite case – a continuous front experiencing a rate as high as those for disrupted fronts – seems truly improbable.

FINDING 7: PEAK CASUALTY RATES FOR ARMY-LEVEL FORCES ARE COMPARABLE WHEN THE OPERATIONAL FRONT REMAINS CONTINUOUS

In light of the foregoing discussion of continuous and disrupted fronts, we can now set our observations under Finding 5 into more proper context.

We noted there that a distinctive aspect of operational-level peak casualty rates is that the highest rates are of comparable magnitude regardless of force posture or success. We will now say this is true as long as the front remains continuous.

If the front is disrupted, considerably higher rates will probably be experienced by the losing defender.

FINDING 8: THE WOUNDED-IN-ACTION RATE AS A PROPORTION OF THE TOTAL BATTLE CASUALTY RATE DECLINES SIGNIFICANTLY WITH EITHER A DISRUPTED FRONT OR A CONTINUOUS FRONT THAT EXPERIENCES RAPID LOSS OF TERRITORY AND CONFUSION

We can now introduce a final consideration to the understanding of casualty rate patterns in terms of continuous and disrupted front experiences. That consideration is the proportion of the total battle casualty (TBC) rate represented by the wounded-in-action (WIA) rate. That proportion changes substantially with different operational scenarios.

Figure 8-2 shows the same five peak 10-day rates as in Figure 8-1 but with the addition of the proportions of those overall rates represented by the WIA rates [in contrast to the killed-, captured-, and missing-in-action (KCMIA) rates].

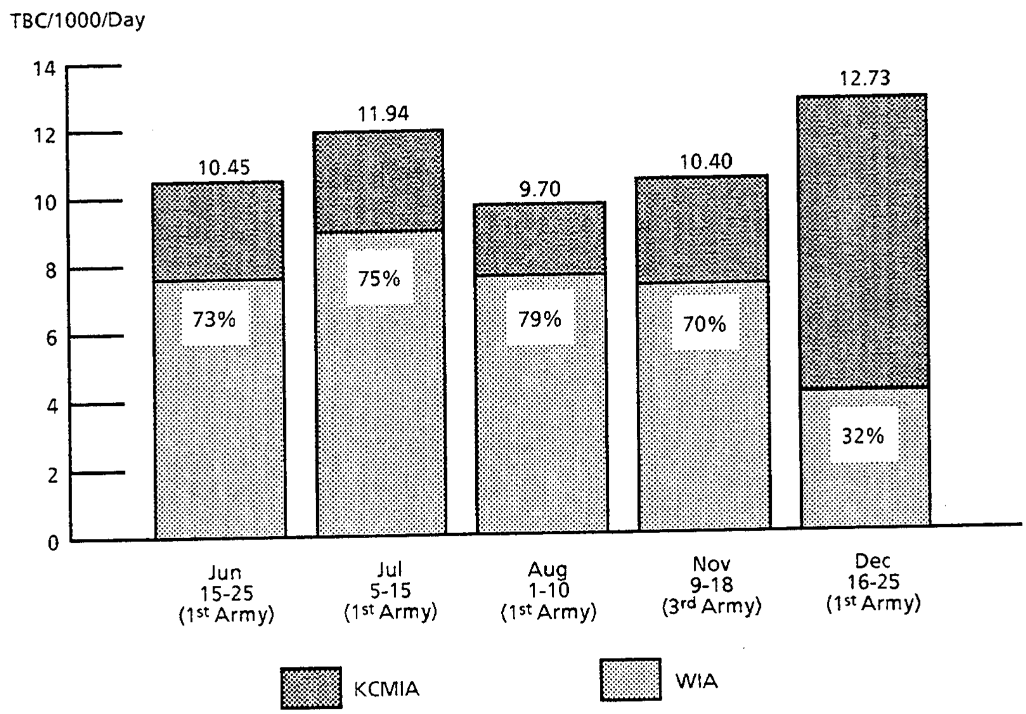

FIG. 8-2. WIA PROPORTION OF U.S. TBC RATE FOR 5 PEAK ARMY 10-DAY PERIODS, 1944

The WIA rate ranges steadily between about 70 and 80 percent of the TBC rate for an army on the offensive and winning. However, the proportion drops to less than half of that for the initial Ardennes defensive period.

If the Ardennes rate is taken to be 10/1000/day (i.e., if the casualty rate excludes the 106th's single-day disaster of two regiments' surrender), the WIA proportion is 41 percent, still down significantly from the 70 – 80 percent otherwise seen. If the army rate is more correctly placed at 13/1000/day (including the two regiments' surrender), the proportion drops to 32 percent. Considering the army's rate in both perspectives again permits a helpful look at the experience: the two regiments' surrender was not the sole determinative factor in the proportion's reduction; the reduced WIA proportion was experienced by the army more generally. A check of the other divisions' experiences, altogether excluding that of the 106th, showed a WIA proportion of 43 percent.

The determining factor in reduced WIA proportions is the setting as a whole. In the case of the Ardennes, the setting was a worst-case continuous front: a defensive effort where considerable ground was lost rapidly and confusion was high. At Lvov-Sandomicrz, the front was disrupted. The WIA proportion of the First Panzer Army's TBC was 28 percent.

The question is why the WIA rate reduces so greatly. The immediate reason is also evident in the data: the numbers of missing-in-action and captured-in-action (MCIA) skyrocket. This single factor marks both of the critical settings where the WIA proportion of the TBC rate drops: the worst-case continuous front that falls rearward rapidly and the disrupted front.

Two other, less obvious reasons may also account for the WIA proportion reduction. Both address the fact that not only does the MCIA rate rise sharply, but the absolute WIA rate itself diminishes. In the case of the Ardennes, for example, many fewer WIA casualties were recorded, per thousand strength, during the defensive's first 10 days than were recorded for U.S. Armies in any of the other peak periods.

The two related reasons are, first, that it is probable (at least in the case of the Ardennes) that some fewer numbers of personnel were in fact hit by fire and, second, that in any case many of the wounded simply disappeared into the ranks of the missing and captured.

It is widely acknowledged that casualty rates for those killed and wounded fall appreciably – on both sides – during an operation where both sides are highly mobile, when compared to situations where the opposing forces stand and fight. Several of the 1st Army's line divisions during the Ardennes defensive, and a goodly portion of the German forces as well, were in such a relatively mobile posture on several of the campaign's first 10 days. The physics of weapons effects does not change in this changed scenario, but the number of accessible targets certainly fluctuates as forces either stand or move.

As to the probability, given a worst-case continuous front or a disrupted front, that significant numbers of wounded are included among the sharply rising numbers of those missing and captured, any answer is speculative. Yet the confusion and disorder across major portions of an entire field army in either situation suggests that probability is high. We suspect this is the greater of the two apparent reasons for the absolute drop in WIA rate.

CHAPTER 9

CASUALTY RATES AGAINST SOVIET OPERATIONAL METHODS

Most of the foregoing characterization of casualty rate patterns stands on data taken from the U.S. 12th Army Group database. The question arises whether those data are sufficiently representative of the kinds of casualty rate experience needed to understand casualty rate patterns.

Comparisons of the 12th Army Group's casualty rate experience with the experiences of other Western forces in World War II show it to comprehend those other experiences. The question then becomes two-fold: whether experience against Soviet forces and operational methods indicates rates that confirm, contradict, or supplement the insights available from the 12th Army Group data; and whether substantial evidence of combat subsequent to 1945 indicates any trend in casualty rates that tends to confirm, weaken, or supplement insights taken from the 12th Army Group data.

This chapter begins to address the first of these questions by presenting evidence of German rates in World War II against the Soviets. Chapter 10 then compares World War II rates to rates sustained in operations subsequent to World War II, including contemporary operations between U.S. and Soviet-style units.

FINDING 9: GIVEN THE SAME CONTEXT, CASUALTY RATES FOR GERMAN FORCES FACING SOVIET FORCES AND METHODS WERE NO HIGHER THAN U.S. RATES AGAINST GERMAN FORCES AND METHODS

In comparing German and U.S. casualty rate experience, we focused first on experiences of particular divisions in major campaigns involving German forces on the Eastern and Western Fronts. Our intent was to check division rates in time segments and sectors of front that were as discrete as possible. Since our principal interest is with rates sustained in operations against Soviet forces and methods, we present data from 12 major campaigns involving highly mobile forces on the Eastern Front. We then looked across the entire set of German data to check for the range and character of rates seen at the various echelons, across the full 4 years of the German experience and including all particular kinds of scenarios.

The 12 Eastern Front campaigns were as follows:

Middle Don	16 – 28 Dec 42
Donbas	29 Jan – 6 Mar 43
Kharkov	2 Feb – 23 Mar 43
Belgorod-Karkov	1 – 31 Aug 43
Kiev	3 Nov – 24 Dec 43
Korsun-Shevchenkovskii	24 Jan – 17 Feb 44
Belorussia	22 Jun – 13 Jul 44
Lvov-Sandomicrz/Kovel	12 Jul – 29 Aug 44
Yassy-Kissinev	20 – 29 Aug 44
Operations in Hungary	26 Oct – 31 Dec 44 1 Jan – 16 Mar 45
East Prussia	Jan – Feb 45
Vistula-Oder	Jan – Feb 45

Data were found for 143 (about 47 percent) of the German divisions involved in these campaigns. We were particularly concerned with casualty rates experienced in the major attack sectors, immediate flanks to the major attack sectors, and secondary attack sectors. To identify divisions by such sectors, each German and Soviet division's place in the action was identified on daily maps showing the course of the action. Casualty data from the 10-day blocks of data in the records were treated two ways. We attempted to identify casualties by shorter time periods; where possible, we divided the 10-day casualty data for the division into two (in a few cases, three) shorter time periods reflecting the division's major phases in the operation. When we could identify such shorter periods and the casualties during those periods, we reduced the division strength in a time increment by the number of casualties allocated to the previous time increment. Thus, casualty data were imputed for the shorter time spans.[1]

Where we found it impractical to identify shorter periods (e.g., when we could not readily identify major different division phases), we calculated the rate for the

[1]We believe it is impossible to allocate such 10-day blocks of casualty data into any more than two or three shorter time increments. The inherent variability of daily rates, discussed in Chapters 6 and 7, suggests that assigning 10 individual daily values would be guesswork.

period of the division's major involvement during the action. Thus, numerous instances of rates covering more than 10 days were established (see Appendix C). Of course, the basic 10-day sets of rates remained available for analysis.

Table 9-1 shows a set of rates drawn from the 12 campaigns.[2] We arrange the data by attack sector and by whether frontage of the sector (or portion of the sector the division occupied) remained continuous or was disrupted.

Table 9-1

World War II GERMAN EASTERN FRONT EXPERIENCE
(Individual division examples)
(TBC/1000/Day)

Sector	Continuous Front		Disrupted Front	
	Rates	Days	Rates	Days
Major attack sector (MAS)	13 – 35 2 – 12	3 – 4 10 – 12	150 – 280[a] 70 – 95[a]	3 10
Flank of MAS	2 – 20	3 – 5	40 – 45[b]	11
Secondary attack sector	2 – 22	3 – 5	40 – 45[b] 27	10 16

NOTE: The rates shown are per 1000 division strength per day, with the number in parentheses showing the number of days of combat represented.

[a] Division at point of breakthrough.

[b] Division encircled, portions break out.

While some of the rates listed in Table 9-1 are extraordinary by Western Front standards, most are quite comparable. We found that the extraordinary rates occurred in all cases at a point of disruption along the German front – a point at which the major Soviet thrust struck and succeeded in breaking open the front. In a few of such instances, the German division lost as much as 80 percent of its strength in as few as 3 days. Most of the rates, however, were not nearly of such magnitude, even for this set of operations.

Comparable rates do exist in the 12th Army Group database, however, to even the highest rates seen in the Eastern Front operations. For example, the 106th U.S.

[2]The full set of recorded division casualty rates sustained in these campaigns, and also arranged by sector, is listed in Appendix C.

Infantry Division's 3-day rate was approximately 253 battle casualties per 1000 personnel per day, typical of divisions in the East that were rapidly destroyed at the point of disruption. The 106th was at the intended point of disruption in the German attack in the Ardennes. No other similar rate exists in the West because no other operation of such scale and power was mounted by the Germans against the Allies in the West. In the single case in which one was mounted, and at least tactical success was achieved at the intended point, the rate occurred.

Yet the German success against this one division did not translate into more than a tactical success. The gap opened in the U.S. front (when the front line of the 106th essentially disappeared) could not be exploited effectively by the German offensive forces before the overall U.S. front withdrew and reinforcements arrived. This is the key to the difference between operations in the East and those in the West.

Seen in this light, the data show that the German casualty experience on the Eastern Front was clearly not worse than U.S. experience in the West *for a given general operational context.* When a general operational setting in the West paralleled those that occurred relatively often in the East, rates are parallel for parallel experiences in terms of echelon, time period, and sector placement.

The German and U.S. experiences clearly differ in the fact that the Germans experienced the equivalent of what might be termed several "Battles of the Bulge" against themselves, many of which succeeded where their own efforts at the actual "Bulge" failed. It is when one looks at the casualty rate details of each such separate operation, and compares them to the appropriate time segments and contexts for a similar force in a Western Front operation, that casualty rate parallels become clear.

Time and resources prevented us from conducting similarly detailed analyses of army-level data covering the remainder of the 4 years of the German experience. We did rank the full set of army 10-day rates[3] (and to do so counted as an army only those instances in which at least eight divisions were included in the army's 10-day block of casualty data, because the U.S. Armies we studied numbered at least eight divisions

[3]Unlike the division data from the several campaigns shown above, no suitable means is known for adjusting the strengths of the divisions in this army's 10-day blocks either to reflect strength reductions during the 10-day periods or to show assigned strengths for those divisions where it is unavailable. (Again, as discussed in Chapter 5, assigned strength is available for the heavier and elite divisions as of spring 1943.) Based on our analysis of the set of divisions in these campaigns, and on insights into casualty rate patterns more generally, it may be speculated that such adjustments could result in increases in these rates of as much as 25 percent. This would still place the rates well within the expected boundaries.

for every period of data used). The full data set of German 10-day army rates numbers 405 cases, only 69 of which have values at or above 3 casualties per 1000 personnel per day. Analysis of the 12th Army Group data indicated that army 10-day rates are "high" if they exceed approximately 6 casualties per 1000 personnel per day. Figure 9-1 displays the only 12 instances in the German 10-day army rates that meet that threshold.

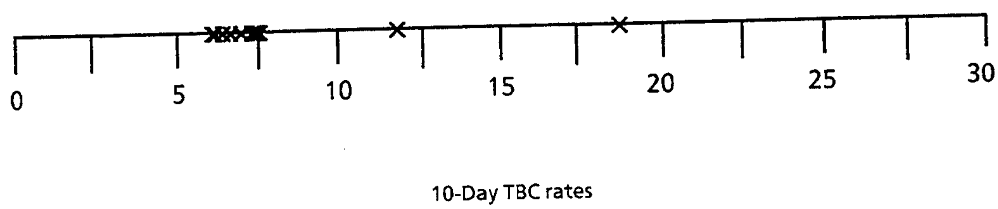

FIG. 9-1. GERMAN ARMY-SIZE FORCE PEAK 10-DAY TBC RATES, 1942 – 1945 (TBC/1000/DAY) – According to Available Data

As in the case of the majority of the more detailed division data from the 12 operations, all but one of these army rates are clearly within the bounds of casualty rate experience in the West. The rate that exceeds the range of highest rates seen in the 12th Army Group data is for the First Panzer Army; that rate is nearly 19 casualties per 1000 per day. We discuss in Chapter 8 how this rate represents a different operational setting from any represented in the Western experience. This exception to the apparent rule of army 10-day rates, defined by the U.S. data and by the remainder of the German data, helped us to establish that army 10-day rate values must be seen in light of whether the front remains continuous or is disrupted.

None of the available data from the German experience against Soviet operational methods suggests casualty rates that differ appreciably from rates sustained in *generally comparable settings* – in terms of echelon, time, and sector – during the course of operations by the 12th Army Group. Most of the German Eastern Front rates in the available data fall well within those seen in the Allied Western Front experience.

Again, this is not to suggest that the Eastern and Western Front casualty rate experiences were identical. The Germans suffered devastating loss rates in numerous campaigns – rates significantly above any army-level experience in the West. The classic defeats of Vistula-Oder and Yassy-Kishinev, for example, saw casualty rates as stunning as the defeats were complete.[4] However, our analysis shows that the casualty rate characteristics of these operations – the patterns of rates associated with breakthrough sectors, or encirclements, or along the rest of the defensive line – were fundamentally congruent with the patterns of casualty rates in the Western experience.

Those few Eastern Front German army-level rates that do exceed most army-level rates in the West appear in broad operational settings – disrupted fronts, especially disrupted fronts with catastrophic encirclements – not experienced in the West. Yet, even here, the Western experience contains parallels to those settings at least in microcosm. Where the parallel is drawn, as in the case of the U.S. 106th Infantry Division in a penetration sector, the same levels of rates are seen.

We conclude that the 12th Army Group database, if its rate data are understood in light of their appropriate operational settings, usefully describes World War II experience both as to the kinds of casualty rate patterns associated with such settings and the underlying casualty rate phenomena (pulses and variability) comprising those patterns. The German Army database offers no contradictory evidence, and in fact quite usefully supplements the insights available in the 12th Army Group data into the major operational-level conditions (e.g., by adding views of disrupted fronts with and without catastrophic encirclements) associated with casualty rate patterns.

World War II experience permits a view of casualty rates in operational-level settings. The data suggest that rates sustained against Soviet operational methods did not differ in the fundamentals of their patterns from rates on the Western Front. Our attention now turns to whether evidence of rates subsequent to World War II,

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[4]The available data exclude many German divisions' experiences. If the available data for particular operations are supplemented by hypothesizing missing divisions' rates (based on other accounts of their experiences), and if at the same time the analysis focuses only on that portion of the German front principally engaged by the Soviet forces in these operations – i.e., if analysis considers only the German divisions engaged rather than the full set of divisions assigned to the German army organizations that were engaged – then 10-day army-level rates in these disastrous defeats could reach the range of 30-to-40/1000/day and possibly even somewhat higher. Such extraordinary rates were driven, it appears, almost exclusively from losses sustained by groups of as many as 5 to 16 divisions catastrophically encircled added to losses to the few divisions in the breakthrough sectors. Without such encirclements, the German loss rates even in disrupted front situations (and even when seen only in terms of the directly engaged forces) fall well into the range of rates seen in the West.

including rates sustained against modern Soviet-style forces, indicates that the World War II perspectives on operational-level casualty rates remain useful.

CHAPTER 10

CASUALTY RATES SINCE 1945

Our final question is whether empirical evidence of casualty rates in actual operations supports the common intuition that rates have increased considerably since World War II. Having reviewed World War II casualty rates from both the Western and Eastern Fronts, we now examine evidence from the Korean War, from the 1967 and 1973 Middle East wars, and from current field exercises at the U.S. Army's National Training Center. Comparisons with World War II rates are made as appropriate.

Our main interest is to judge the reasonableness of projected 10-day rates for a theater force.[1] Ten-day rates are averages. But average rates mask the daily rate experiences that are crucial for answering our question. We have shown previously how casualty rates occur in pulses and show significant daily variations in magnitude. Only actual daily rates can define the range and distribution of such rate possibilities. Averaged "daily" rates in fact represent multiple days of combat – worse, multiple days for multiple units – and thus hide all the rate possibilities and variability inherent in that circumstance. Even periods of as few as 3 or 4 days are likely to contain dramatic variations in rates for each unit.

Resolving whether casualty rates are higher since World War II therefore requires, first, examining sets of 1-day rates that are capable of showing the actual range and distribution of rates in the respective eras.

Second, although our principal interest is in rates for theater-level forces, comparisons of World War II rates with subsequent rates cannot be made between operational-level forces. No operations (for which appropriate data are available) subsequent to World War II are comparable in terms of force size and time to the scope seen in that war. The only direct comparisons of actual daily rates that are

[1]U.S. Army theater forces in Europe operate generally as corps and comprise at least one army-size force. We are concerned as well, however, with forces that may be division-size or smaller in order to examine U.S. Marine Corps theater contingencies. In Europe, these forces and their settings of course form a part of the larger operational-level whole.

possible are limited to tactical operations. Our comparison must, therefore, be based on 1-day operations at the tactical level. This fact, however, signals a caution.

Casualty rates of tactical events that occur in an operational-level setting are likely to differ from casualty rates of tactical actions occurring in a setting limited to the tactical sphere. For example, an isolated division or corps engaged in a battle of short duration (say, a day) against a single enemy force is more likely to be able to focus in a sharp, intense effort than the same division or corps could during any 1 day of a large-scale, many-day operation as part of a much larger force engaged against a comparable enemy force of many tactical parts. The division or corps in the latter operational-level situation must simply attend to a greater number of tactical possibilities – actions by both other friendly and of course enemy forces – than would the division or corps engaged in the narrower, strictly tactical setting. One would expect, then, that combat intensity for a single day's activity would on average be greater in the more narrowly defined circumstance, and casualty rates would be higher.[2]

This caution is speculative. But it suggests that rates for similarly sized tactical units for similar time increments might differ systematically between settings that are strictly tactical and settings that are parts of the operational level of war.

With this caution bearing on expectations about results, comparisons of tactical rates drawn from the two settings are appropriate.[3] All these points considered, formal statistical comparisons are appropriate only between the Middle East wars and World War II and between the National Training Center (NTC) exercises and

[2]These observations on expectations are general in nature but also are made particularly in light of this chapter's task of comparing casualty rates from the Middle East with U.S. rates from World War II. The general expectation described may not, however, apply to the targeted defender unit(s) in the narrow breakthrough corridor of a Soviet-style major attack sector. As suggested elsewhere in the text (especially in Appendix G under "Note Regarding Casualty Rate Expectations"), traditional Soviet practice of the operational art is structured in some circumstances (where the defender is well prepared) to focus such combat power at the tactical level that successful results will have immediate and significant operational-level impact. This impact is the disrupted front situation described in Chapter 8.

[3]Inferences about average casualty rates possible at the operational-level may sensibly be drawn using the results of these lower level, tactical comparisons. They can be drawn by identifying rates likely at the tactical-level and then grouping those rates in the rate patterns relevant to operational-level settings (e.g., taking care that only a portion of the overall force has high rates on any given day, that any given division's high rates vary over time with lower ones, etc.).

World War II. Only informal comparisons (i.e., not testing hypotheses) are possible between the Korean War and World War II.

FINDING 10: WHERE DIRECT AND APPROPRIATE COMPARISONS ARE POSSIBLE, EMPIRICAL EVIDENCE SHOWS NO SIGNIFICANT INCREASE IN CASUALTY RATES SINCE 1945

KOREAN WAR

With two exceptions, casualty data for the Korean War do not afford a view of actual daily figures and rates. The two exceptions are cases in which the operation involved a single division and lasted a single day. This described only 2 of the 85 actions accounted for in the database.

No statistical comparisons of the Korean War rates to those from World War II were possible given the paucity of true 1-day data from Korea. Instead, we made informal comparisons after grouping the Korean War data into categories by battle duration and by numbers of participating divisions. The comparisons with World War II data were made in terms of wounded-in-action rates. In all cases, the Korean War experience as recorded by Reister was at, or far more often, below the rates for intense combat by comparable numbers of divisions and time periods in World War II.

Two of the more instructive Korean War casualty rate experiences – neither one affording true single-day rate information – were the period of the first North Korean invasion (July 1950) and the period of the surprise Chinese Communist counter-offensive (November-December 1950). The two may represent the highest casualty rates for Army forces in Korea of such size (three and six divisions, respectively). The casualty rates (killed plus all wounded) averaged 5.51 and 6.46 per 1000 personnel per day, respectively.

The two periods' rates are instructive about casualty rates more generally because of what they fail to reveal. First, they do not reveal the fact that particular tactical units (certain battalions and companies) within these larger force aggregates were nearly eliminated by enemy action – as has been well documented elsewhere. That is, a casualty rate may appear relatively low – certainly, these rates are lower than those of comparably sized forces and time periods in certain actions in World War II – yet contain within it rates that are devastating for certain of the subunits involved. The same kind of disastrous experience for some particular divisions is often hidden, for example, within a seemingly low rate for an army's-worth of divisions (say, 10 to 15) over a 10-day time period.

The second perspective on actual casualty rate experience lying hidden in the data for these two particular operations concerns their broad settings. These two episodes represent disrupted operational-level front situations. In such scenarios, both the Western and Eastern Front data from World War II suggest the majority of battle casualties will be those missing and captured. Yet, as noted in Chapter 5, the Korean War database excludes missing and captured casualties. If we accept as applicable to a disrupted front the range of proportions of wounded to total battle casualties suggested by the first 10 days of the Ardennes experience, then the total battle casualty rates for these two operations, respectively, would be 7.8 – 10.4 and 13.7 – 18.2 casualties per 1000 personnel per day.

The two operations involved, again respectively, the equivalent of a smaller corps (3 divisions) and of a large corps or possibly two smaller corps (6 divisions). Given those force sizes and the time periods involved (31 and 21 days), these rates are of course high, even by World War II standards, but not extraordinarily so. Given that the rates represent tactical events within larger severely disrupted operational fronts, the rates are by no means unexpected.

Other rates from the Korean War database vary, as expected, both in terms of force size and time period and in absolute terms within those categories. None of the rates appears significantly higher than rates for comparable forces, times, and sectors in the World War II databases. Most, as noted, appear significantly lower.

MIDDLE EAST WARS

Data Selection

Casualty data available for the two Middle East conflicts of 1967 and 1973 cover 52 battles. Our comparison criteria required that the data selected for making comparisons represent single days of combat for single units.

Thirty-seven of the 52 battles were single-day affairs. Thirty-nine of the 52 involved, at least nominally, a single division on one or both sides. Twenty-five combined the properties of being single-day battles involving a division (nominally) on at least one side. The 12 other single-day battles involved other-than-division forces (nominally), while the 14 other battles with a division (nominally) on at least one side lasted for 2, 3, or 4 days.

We raise the point about a unit being a "nominal" division because, whereas the command was called a division its actual force size might have been considerably smaller or larger than usual division size. Likewise, the command may have been a brigade or a corps and yet ranked in a division-size range. Such strength ranges are of course subject to different professional judgments. The strength range we used to define a division of that era – in order to be conservative – was between 10,000 and 23,000. With respect to single-day battles, this resulted in five cases of nominal Israeli divisions being grouped with brigades, one case of an Israeli division being grouped with corps, one case of an Israeli brigade being grouped with divisions, one case of an Arab division being grouped with corps, and two cases of Arab brigades being grouped with divisions.

These changes, while necessary, had minor effects on the respective Israeli and Arab data sets. Nineteen of the 25 nominal Israeli divisions maintained their places, while 13 of 14 nominal Arab divisions maintained theirs. The effect of the changes on Israeli rates was to lower the mean casualty rate by 0.8 casualties per 1000 personnel per day; no change occurred in the median rate. The effect of the changes on the Arab rates was to lower the mean rate for Arab divisions by 0.9 and to raise the median by 3.0.

This process left us with 20 cases of Israeli rates and 16 Arab cases, or 36 total cases. Factors concerning the World War II data, described below, further limited the comparison to 18 Israeli cases, or 34 total cases.

Before we made the principal quantitative comparison between Middle East and World War II single-division/single-day rates, another comparison was made. It was desirable to see whether the Middle East data supported our general observation from the World War II data that rates will reflect both echelon (force size) and time period: rates will generally be higher for the lower echelons and times, and lower as either force size or time period increases. Because the amount of Middle East data meant the size of the cells for each of these categories (echelon by duration) would be so small, no more than conformance with the general pattern could reasonably be expected.

The full sets of Israeli and Arab rates were therefore arrayed by force size (both by number as described, and by nominal echelon), duration of battle (days), and posture (offense or defense). Many combinations were possible; none of the results were surprising. Both within each set of rates (Israeli and Arab), and when the sets were combined, the rates behaved in accordance with expectations. To take one example, when the sets were combined for single-division/single-days in the defensive posture, the mean rates dropped steadily with increased battle duration. The 16 actions lasting one day showed a mean rate of 39 casualties per 1000 personnel per day, while the mean rates for the 9 actions lasting 2 or 3 days dropped to about two-thirds of that (25/1000/day).

As noted, this sort of comparison indicates only that the general rule relating rates to echelon and time holds true for the Middle East. More formal procedures are needed to establish whether, when Middle East and World War II data are analyzed as closely as possible, the rates are comparable.

Comparing the Middle East rates to those of World War II required selecting an appropriate set of data from World War II. This requirement should be straightforward. Yet the inclination is too often followed, it appears, to base such a comparison on the full set of World War II data, that is, to compare both the Middle East and World War II sets of data without selection in either case. The result of this would of course be to show Middle East rates considerably higher than those from World War II. But the comparison is fallacious. It pits data from a small group of units (mostly divisions) fighting brief (mostly 1-day), intense clashes against data drawn from an enormous number of units fighting actions of varying length and size along wide fronts over periods lasting months or longer.

The selection of World War II data had to be guided by the character of the far smaller set of Middle East data with its narrower circumstances. As pointed out in Chapter 3, however, it was neither possible nor desirable to attempt the selection of World War II data based on the precise tactical details of the Middle East data. While the breadth of the World War II rate set had to be narrowed to reach comparable experiences, overspecification was to be avoided. Too much specification would tend to eliminate the very variety of circumstances, and the associated variety of casualty rates, that must be represented in a study focused on the range of likely possible rates. The basis of comparison had to be keyed on Middle East circumstances, but only in a rough sense.

The selection of data from World War II was made from the 12th Army Group database. The selection began with identifying corps experiences that seemed in a general way to parallel those encountered by the forces in the Middle East conflicts. The parallel was initially that the corps be significantly engaged for periods of roughly 1 to 3 weeks. It was further judged that these experiences should include operations on both the offense and defense, operations mainly in open (nonurban) terrain and, if possible, also some operations representing urban combat.

Five such experiences were selected. They included operations during the "Cobra" breakout period from the Normandy lodgment (July 1944), operations during the period of approach to Germany (November 1944), including the capture of the town of Schmidt, and operations during the initial period of the Ardennes defensive. In all, eight corps were selected during the five periods.

The selection focus then shifted to those divisions within the corps that bore the major weight of action over the time period, as indicated by casualty rates. Divisions were selected not because their casualty rates were necessarily highest on any given day – some divisions not chosen had higher rates on some days than the ones selected. Instead, they were chosen because their rates over the full period indicated that their actions were the mainstay of the overall corps rate. Likewise, for those divisions selected, single-day rates were not selected because they exceeded some predetermined threshold for high rates; in fact, the reverse was true. We used all the rates of the selected divisions that merely exceeded a low-level minimum rate. That minimum was 5/1000/day, which had been previously identified (during the overall analysis of rate patterns for the 12th Army Group) as indicating a reasonable lower boundary of significant combat intensity.

The choice of this lower boundary then meant that the same boundary had to be applied to the Middle East data as well. This accounts for the Israeli data set being reduced from 20 to 18 cases, the two omitted cases falling at 3/1000/day. (The exclusion of these two cases affected the mean and median rates of the set of Israeli data more than had the original Middle East selection criteria that focused on force size. The mean casualty rate rose from 15.0 to 16.3, while the median rose from 9.5 to 10.5.)

The overall selection process just described resulted in a set of 122 single-division/single-day rates from World War II, and sets of 18 and 16 single-division/single-day rates from, respectively, the Israeli and Arab sides of the Middle East conflicts (or 34 total cases). These data sets were judged appropriate for statistical comparison, though the combined Middle East data set is only of moderate size.

Data Analysis

Our main comparison was the combined set of all Arab and Israeli divisions versus the set of selected World War II divisions. It was plain the Arab and Israeli data represent altogether different combat experiences. We combined the Arab and Israeli experiences because we think that together they probably better represent the range of rates that might be seen in modern combat than does either experience alone. We compared the combined set of rates to U.S. experience in Europe in World War II.

Summary statistics are shown in Table 10-1 for the following data sets: the selected U.S. divisions from World War II; Arab and Israeli divisions (combined); Arab divisions; and Israeli divisions. The observations are one-division/one-day TBC rates. See Table 10-1.

TABLE 10-1

ONE-DIVISION/ONE-DAY SUMMARY STATISTICS

Statistic	WWII	Combined Arab-Israeli	Arab	Israeli
Number of observations	122	34	16	18
Mean	23.93	28.59	42.38	16.30
Standard deviation	22.80	29.73	37.80	10.90
Skewness	2.72	2.94	2.20	1.06
Maximum	149.00	138.00	138.00	36.00
75th percentile	30.00	35.00	40.00	21.00
Median	16.00	19.50	32.00	10.50
25th percentile	10.00	10.00	20.50	9.00
Minimum	5.00	6.00	15.00	6.00

Graphic displays of the data in our principal comparison are shown in Figure 10-1 (histograms), Figure 10-2 (survivor curves), and Figure 10-3 (box plots).[4]

FINDING 10(A): THERE IS NO PRACTICAL DIFFERENCE BETWEEN THE FULL SET OF ARAB AND ISRAELI DIVISION CASUALTY RATES IN THE 1967 AND 1973 MIDDLE EAST WARS AND THOSE OF U.S. DIVISIONS IN ROUGHLY COMPARABLE SETTINGS IN WORLD WAR II.

FINDING 10(B): ARAB DIVISION RATES WERE SIGNIFICANTLY HIGHER THAN THE SELECTED WORLD WAR II RATES.

FINDING 10(C): ISRAELI DIVISION RATES WERE SIGNIFICANTLY LOWER THAN THE SELECTED WORLD WAR II RATES.

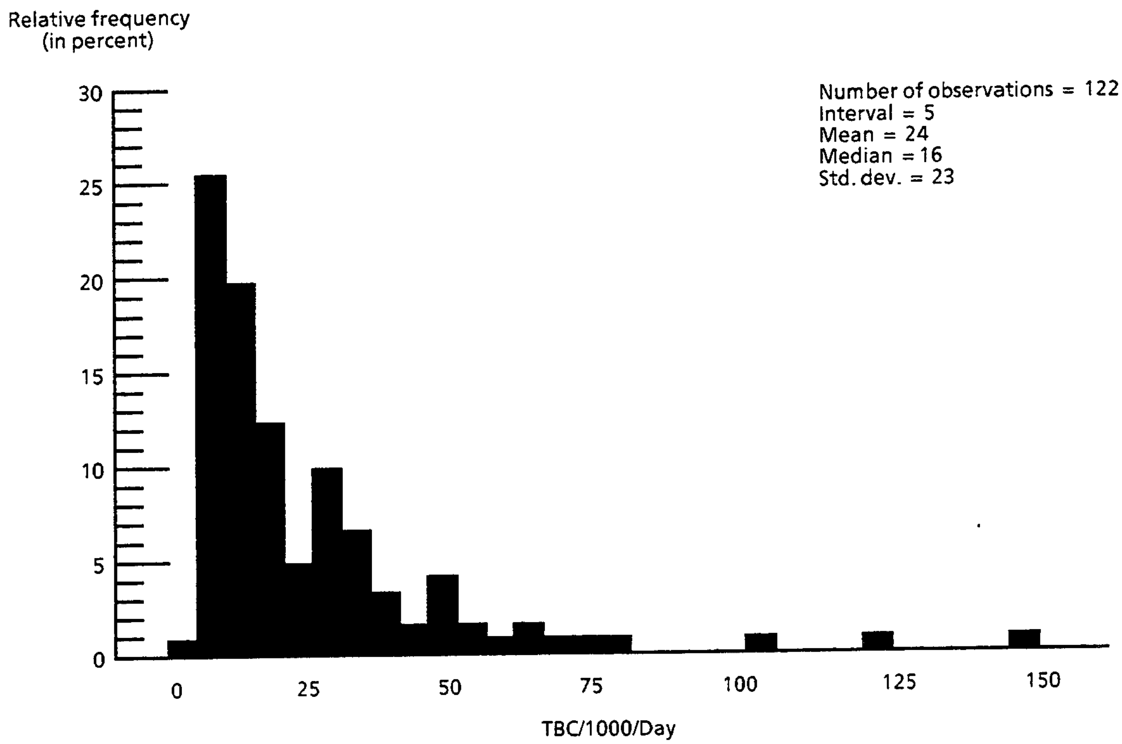
Arab-Israeli (Combined) versus World War II.

We were struck by the similarity between the experiences of divisions in the Middle East wars and those of the U.S. divisions in World War II. Whether turning to the tabular data or to the displays, the agreement between the two distributions is so close as to be remarkable when viewed in terms of the widespread notion that rates since World War II must be significantly higher.

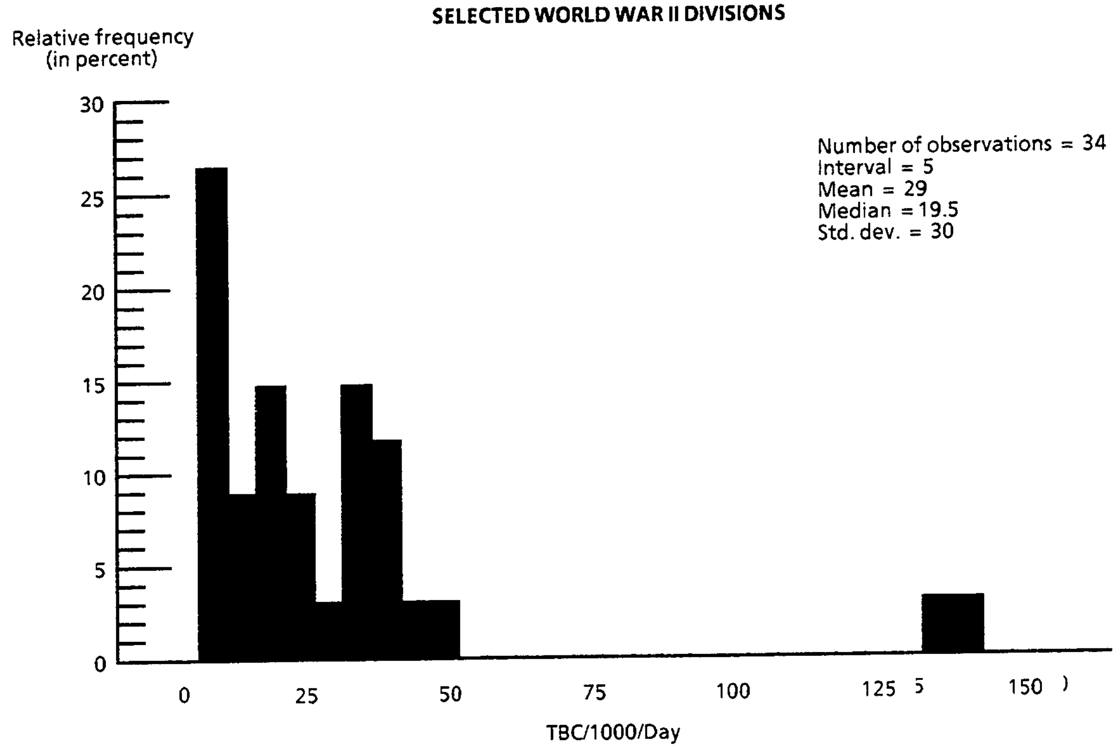
The combined Arab-Israeli rates are about 20 percent higher in the middle (mean and median) of the distribution. Several considerations, however, point to the conclusion that this difference is of no practical significance.

First, we were conservative when setting up the World War II distribution, and thus used the recorded rather than the far higher corrected (reconstructed) rate for the U.S. 106th Infantry Division on 19 December 1944 (when the division lost two of its regiments). Substituting the corrected rate moves the World War II mean up to 28, nearly identical to the combined Arab-Israeli mean of 28.5. (The medians do not change.) On the other hand, had we originally set up the Arab-Israeli distribution without its own two highest rates that are apparently outliers, the resulting mean for the combined Arab-Israeli set would have been 22, which is below the World War II mean of 24 that similarly excludes one surprised division's true peak rate as an outlier. This alternative approach to the Arab-Israeli data would have lowered the

[4]The box plot we use is a simplified way of viewing a frequency distribution. It depicts the range, the inter-quartile range (the part enclosed in the box), and the median.



SELECTED WORLD WAR II DIVISIONS



ARAB AND ISRAELI DIVISIONS

FIG. 10-1. HISTOGRAMS OF U.S. AND ARAB-ISRAELI CASUALTY RATES

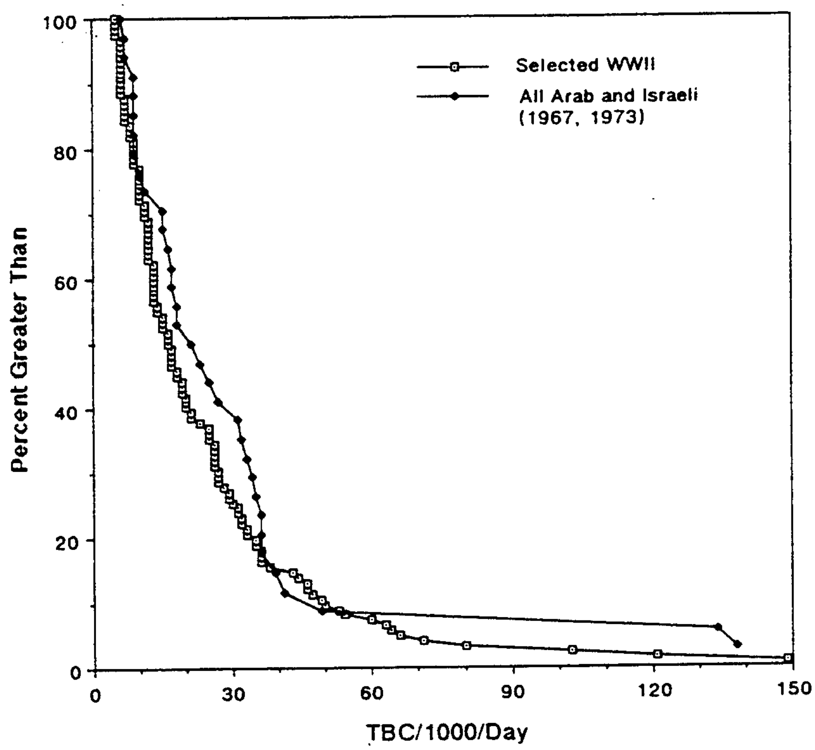


FIG. 10-2. SURVIVOR CURVES OF SINGLE-DIVISION/SINGLE DAY CASUALTY RATES

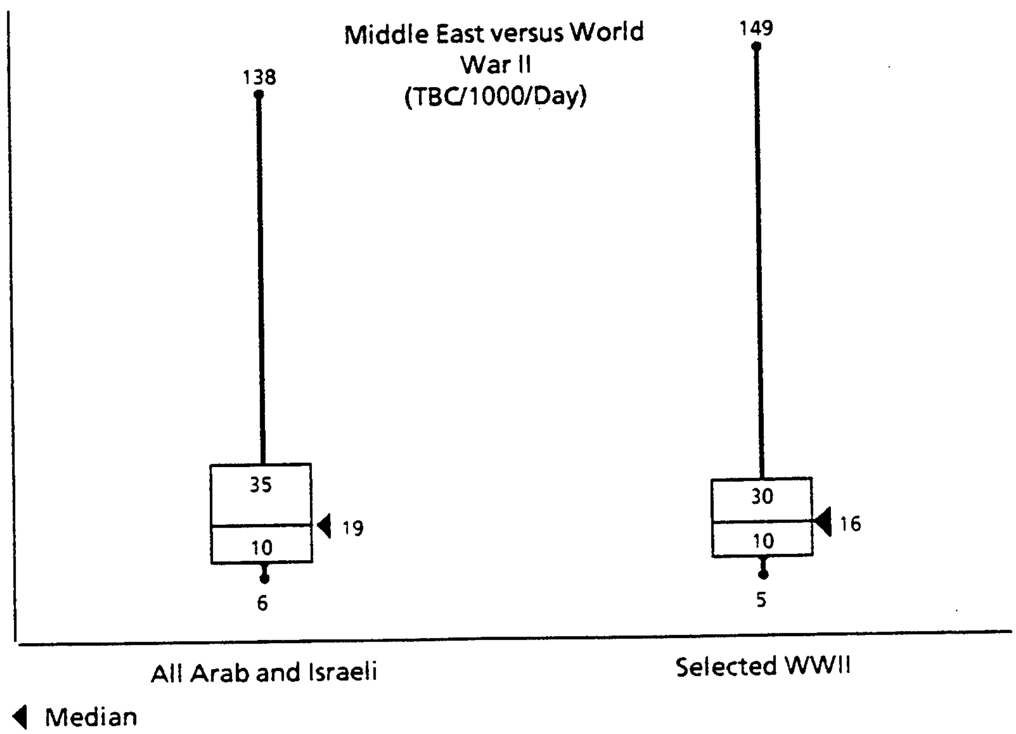


FIG. 10-3. BOX PLOTS OF SINGLE-DIVISION/SINGLE-DAY CASUALTY RATES

median to 18, compared to the World War II median of 16. The conclusion of either alternative approach is to highlight the fact that the difference between the two distributions' averages is more a product of our conservative statement of the World War II data than a general difference in the distributions.

A second consideration suggests that far more important than any such excursions on the two rate sets is the point we raised in introducing this chapter. One would expect tactical rates drawn from a strictly tactical setting to be higher, on average, than tactical rates drawn from operational-level scenarios.[5] Given that expectation, the fact that the far smaller set of Arab-Israeli rates averages only 3 or 4 points higher than the conservatively stated World War II rates (and at a casualty rate level ranging from 16 to 28/1000/day) suggests quite equivalent casualty rate experiences.

In any case, the more useful comparison looks across the full distributions of the 2 data sets rather than only at averages. The clearest picture of the full distributions is afforded by the survivor curves (Figure 10-2) and the box plots (Figure 10-3). The respective values are close enough across the full range of the distributions (even with the World War II data stated conservatively) that formal statistical hypothesis testing is unnecessary to establish that there is no practical difference between them. Not surprisingly, statistical tests on the distributions reach the same result (see Appendix G).

Arab and Israeli (Individually) versus World War II

Examining the histogram for the combined Arab-Israeli data (Figure 10-1) suggests general similarity with the World War II data if one allows for the fact the Arab-Israeli set is so much smaller. Both sets have modes between 5 and 10, and a tail skewed to the right. However, the Arab-Israeli set perhaps also suggests a second mode in the range of 30 to 40/1000/day, in contrast to the clear single mode of the World War II set.

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[5]As noted above (see Note 2), an exception to this general expectation might be the small set of rates of the defending division (or perhaps a few divisions) at the point of breakthrough in a narrow operational-level Soviet main attack sector.

We believe this bi-modal aspect of the Middle East Data rests on the distinctly different casualty rate experiences of the 2 mismatched opponents.

We show only two graphs of the Arab (Figure 10-4) and Israeli (Figure 10-5) experiences compared individually to U.S. experience in World War II.[6] The Arab casualty rates ran nearly uniformly higher than those of the U.S. The one exception is at the high end, where a U.S. division experienced a somewhat higher rate than the two highest Arab rates. Figure 10-5 is equally clear that Israeli casualty rates were lower than the U.S. rates.

Again, no resort to formal statistical tests is needed to show the practical differences in the individual sets of Arab and Israeli experiences. We do not believe, however, that taking either the Arab or the Israeli experience alone permits a very helpful comparison with the World War II data – or with casualty rate possibilities that might be envisioned for a future conflict in Europe.

SUMMARY

The better approach is to combine the 2 sets of Middle East data, as above. The combined set suggests that empirical evidence of divisional casualty rates from actual combat as recent as the mid-1970s shows no indication of rate increases when compared to World War II experience.[7]

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[6] We have excluded the one-day catastrophic experience of the U.S. 106th Infantry Division, with a rate of 577/1000/day.

[7] Taking both the combined Middle East data set and the World War II data may suggest a distribution of rates which would describe most of the intense rates for U.S. divisions in a future European conflict, assuming even a worst-case continuous front. It is of course possible to envision the rare catastrophic single-day rate – similar to that of the U.S. 106th Infantry Division on 19 December 1944 – for a division in a main attack sector. Given today's divisional frontages, however, such a rate might also suggest a disrupted front with all that might entail in the European setting for defenders without appreciable strategic depth.

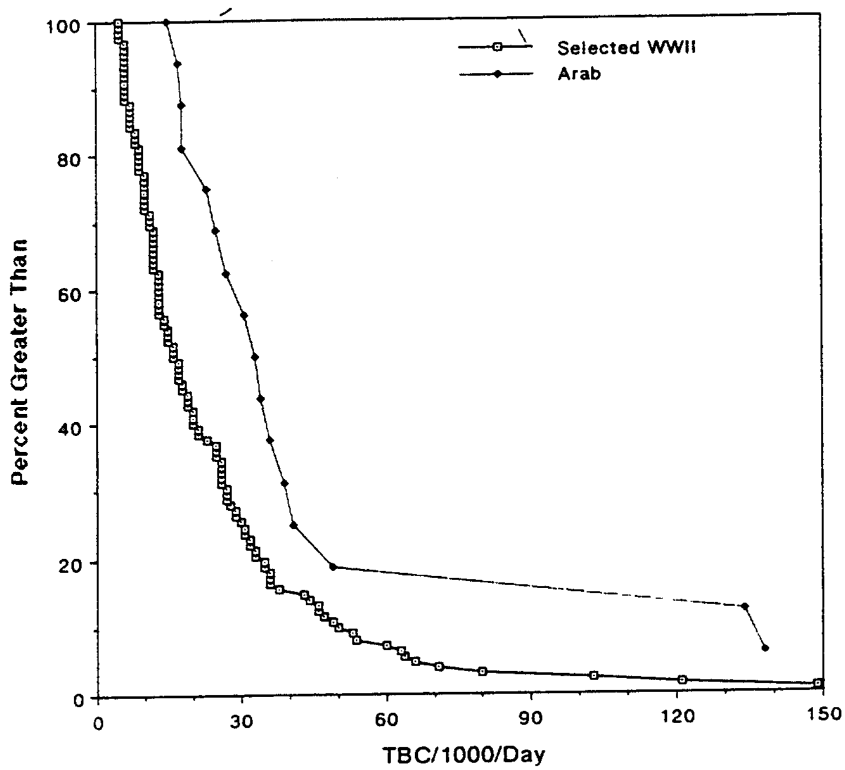

FIG. 10-4. SURVIVOR CURVES OF ARAB-ONLY VERSUS WORLD WAR II RATES

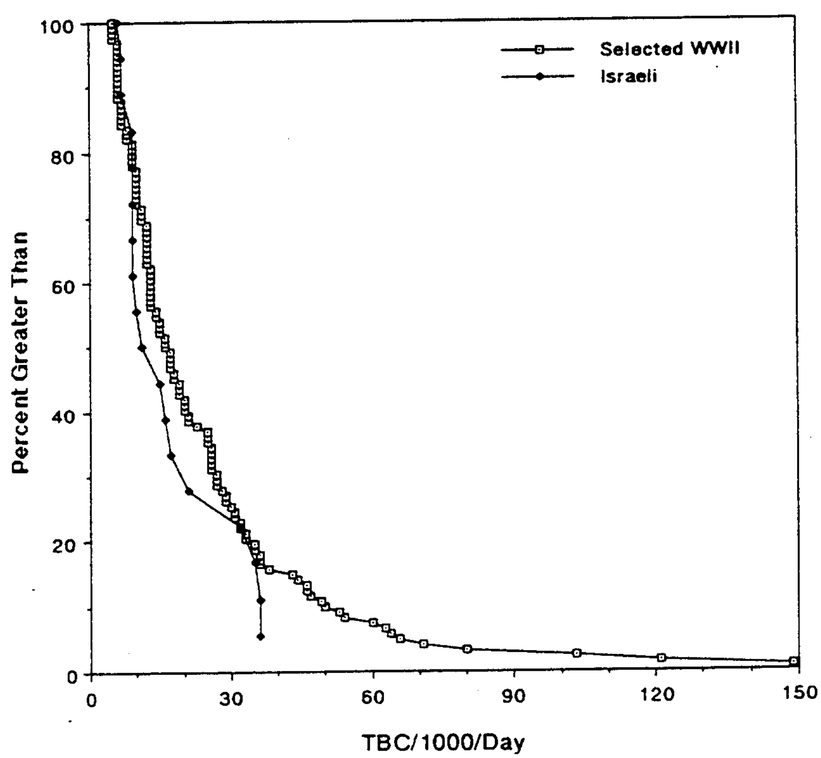

FIG. 10-5. SURVIVOR CURVES OF ISRAELI-ONLY VERSUS WORLD WAR II RATES

NATIONAL TRAINING CENTER

Data Selection

We reviewed more than 300 sets of battalion operations representing one-battalion/one-day engagements. These exercises were held from 1985 through 1988.

A sample of these operations needed for analysis was chosen specifically to be as balanced as possible. We desired that the sample represent both armored and mechanized Army battalions, that these evenly represent offensive and defensive posture, and that as far as possible these also represent battalions with both "modernized" and "nonmodernized" equipment.

Table 10-2 shows the sample arrayed by "Blue" unit type and posture. Excellent balance was achieved with regard to unit type and posture. Unfortunately, the difficulties of identifying complete sets of battalion data, plus the fact that most Army units at the NTC are still nonmodernized, meant the sample was not balanced as between modernized and nonmodernized battalions (see counts in Table 10-3).

Table 10-2

CONTEMPORARY FIELD EXERCISES
U.S Army National Training Center

Posture	Number of Battalion Observations		Total
	Armor	Mechanized	
Attack	43	33	76
Defense	31	32	63
Total	74	65	139

Table 10-3 shows a summary of casualty rate results for both "Blue" and "Red" forces at the NTC. Strong reason exists to discount the "Blue" casualty rates by some amount. This discounting of rates would compensate for several factors either unique to the NTC environment (and not expected if an actual U.S. battalion task force in Europe encountered an actual Soviet/Warsaw Pact opponent) or outside this study's analytic framework.[8] We estimate (based largely on discussions with knowledgeable Army officials) that such a discount could reasonably reduce the NTC rates by 25 to 50 percent or more. Any such discount is uncertain, however, and we therefore decided not to attempt a discount. The NTC rates cited are undiscounted.

A set of battalion casualty data from World War II was needed against which the NTC battalion data could be compared. As in the case of the Middle East/World War II comparison, the selection of this data set from World War II was more involved than its counterpart.

The set of World War II battalion data is taken from the "Battles" database. These World War II battles had originally been selected for study because of their general resemblance to possible future tactical scenarios in Europe between conventional forces, with attention given to both unit types involved and to postures represented. The data actually gathered – especially that for units below division level – was a function of its availability in the archives and within the project's staffing constraints.

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[8]Factors unique to the NTC start with the excellence of the "Red" opposing force, which has conducted operations at the several NTC exercise sites literally scores of times against nearly every conceivable U.S. defensive or offensive posture. This NTC "Red" force knows its opponent, the terrain, and itself far better than could be expected of an average (or perhaps even an elite) actual "Red" force. The unique NTC factors also include terrain that provides substantially less cover for defenders and attackers than most European settings. And, of course, the NTC is only a training environment in which, though units and individuals train seriously, the psychological and physical realities of combat cannot be fully replicated.

Beyond these overt factors that overstate casualties lie less obvious factors. For example, NTC rules count all crew members of a "killed" vehicle as battle casualties although combat data clearly show such casualties would average at most one-half the crew. A problem also exists for this study, which focuses on conventional battle casualties, in that NTC's "Red" force typically employs simulated chemical agents in its attacks. The effect of these agents is sometimes negligible (2-3 percent of battle casualties, or no effect whatever if the weather precludes using chemicals) and sometimes quite significant (accounting for 25 percent or more of the casualties).

These unique factors tend toward overstated casualties. On the other hand, we were concerned that artillery play may be understated at the NTC. The concern persists even though artillery play is apparently far improved today over the early- to mid-80's; for example, artillery volleys *and target vehicles (by hull numbers) within their burst radii* are electronically recorded, and this information is immediately passed to the NTC observers who register vehicle kills from indirect fire. Therefore, the tagging of victims is not the largely arbitrary exercise it once tended to be. Still, whatever understatement of casualties may remain from artillery play appears easily outweighed by the cumulative effect of the various factors overstating casualties. (We have been informed that a strong body of expert opinion on Soviet practices holds that, in fact, Soviet artillery is overstretched at the NTC; that is, the artillery appears more representative of a Soviet main attack sector than of a flank to such a sector.)

TABLE 10-3

CASUALTY RATE EXPERIENCE – 1 DAY ENGAGEMENTS
U.S. ARMY National Training Center, 1985 – 1988
TBC/1000/DAY

Type: "Blue" Task Force Posture/	AR			MX		
	Total	Modernized	Non-modernized	Total	Modernized	Non-modernized
Attack/						
Count	43	11	32	33	5	28
Minimum Blue Rate	36	36	89	52	129	52
Maximum Blue Rate	307	263	307	373	182	373
Average Blue Casualty	160	124	174	170	156	172
Median Blue Casualty	148	126	170	161	162	156
Minimum Red Rate	169	169	242	108	117	108
Maximum Red Rate	881	646	881	905	757	905
Average Red Casualty	459	360	511	428	312	452
Median Red Casualty	456	416	472	488	244	496
Defense/						
Count	31	6	25	32	6	26
Minimum Blue Rate	38	89	38	24	64	24
Maximum Blue Rate	449	154	449	371	215	371
Average Blue Casualty	152	121	160	167	149	171
Median Blue Casualty	135	124	142	172	136	174
Minimum Red Rate	92	420	92	79	79	90
Maximum Red Rate	857	805	857	899	499	899
Average Red Casualty	487	574	467	317	249	334
Median Red Casualty	484	528	460	344	208	392

Twenty-eight battles were originally identified for the "Battles" database, and we found useful data on 26. Of these, 20 were judged applicable scenarios for a conventional war in Europe. We located data on battalion casualty rates for 13 actions.

Battalion data were then selected out of that available on the basis of several criteria. First, the data needed to indicate true daily rates of each battalion, rather than merely averaged "daily" rates covering the battle period. This reduced the 13 battles to 12 acceptable ones and produced the basic set of World War II battalion data used for this analysis.

That set of 12 battles includes 48 division days and 329 battalion days. We further defined the required data by identifying battalion rates that represented intense battalion engagements. The need for data on intense battalion experiences arose from the fact that the NTC scenario represents a "worst case" battalion situation, that is, a very intense battalion engagement. The 329 World War II battalion days in the derived database of course included many that were not intense. Subunits of a division experience varied combat intensities on any given day, just as divisions do across an army front.

We first excluded all battalion rates where the division itself sustained a rate below 5/1000/day, the rate that had previously (in an unrelated analysis) been selected to indicate a minimum level of significant division combat intensity.

We then arranged each of the 12 battles into a daily picture of the remaining divisions' casualty rates and the rates of their several battalions. The ratio of the rate of each battalion to that of its division was calculated. From a review of the overall group of ratios thus determined, we judged how the ratios of rates grouped themselves, that is, what classes of ratios seemed apparent.

A ratio of the battalion-to-division casualty rates of 4:1 or greater for a day's combat seemed a sensible determinant of the battalions in intense combat. Other studies have suggested that a ratio of 9:1 would capture the relative rates of battalions intensively engaged to their divisions. We felt the 4:1 figure was a conservative standard. This procedure produced 40 battalion values.

However, we did not want either to exclude battalion rates that were clearly high although their ratio fell below the 4:1 mark, or to include battalion rates that far exceeded the 4:1 mark, were apparently not high. In the former cases, the ratio was low (in the range of 3.0:1 to 3.9:1 or, in three cases, between 1.4:1 and 2.6:1) because the division itself sustained an unusually high rate. In the latter cases, the ratio was inordinately high (for example, approaching 15 – 20:1) because the division's rate was so low.

We decided to accept battalion rates where the ratio fell below 4:1 in 11 cases in which the rate in question seemed clearly to warrant inclusion in the set of rates representing intense battalion engagements.

The comparison of NTC to World War II data was initially made with the set of 51 battalion rates thus determined. It seemed likely, however, that the overall situation represented by the NTC scenario – the immediate flank of a major Soviet-style Frontal attack sector – would find the division to which the NTC battalion belongs itself sustaining a rate considerably higher than 5/1000/day on the day in question. Therefore, two other minimum division rates were identified from the set of World War II data to represent alternative division combat intensities for such a sector.

These alternative division rates were 20/1000/day and 15/1000/day. The former rate had been identified during previous study of 12th Army Group data, and data from other Allied divisions, as indicating an intense division combat day. The latter was chosen in order to remain conservative and yet still represent an intense division combat day.

Those final two sets of World War II intense battalion combat days comprise 33 values (for those from divisions with rates of 20/1000/day or greater) and 38 values (from divisions with rates of 15/1000/day or greater). These latter sets were extracted from the initial set of 51 values and thus are nested subsets of that initial set.

Data Analysis

We compared the set of undiscounted NTC battalion casualty rates to each of the three nested subsets of rate data for selected World War II battalions.

Summary statistics are shown in Table 10-4 for the following data sets: NTC, and selected World War II for division threshold rates of 5, 15, and 20. The observations are one-battalion/one-day TBC rates.

Graphic displays of the data are shown in Figure 10-6 (histograms), Figures 10-7, 10-8, and 10-9 (survivor curves), and Figure 10-10 (box plots).

FINDING 10(D): CASUALTY RATES AT THE NTC SHOW NO INCREASE OVER RATES SUSTAINED IN WORLD WAR II

The most striking feature of these comparisons is the contrast between the well-behaved, nearly Gaussian, small-variance distribution of the NTC data and the irregular, highly skewed, large-variance distribution of the World War II data. (See Figure 10-6.) The contrast is between a relatively controlled training environment and actual combat where situations and actions vary widely.

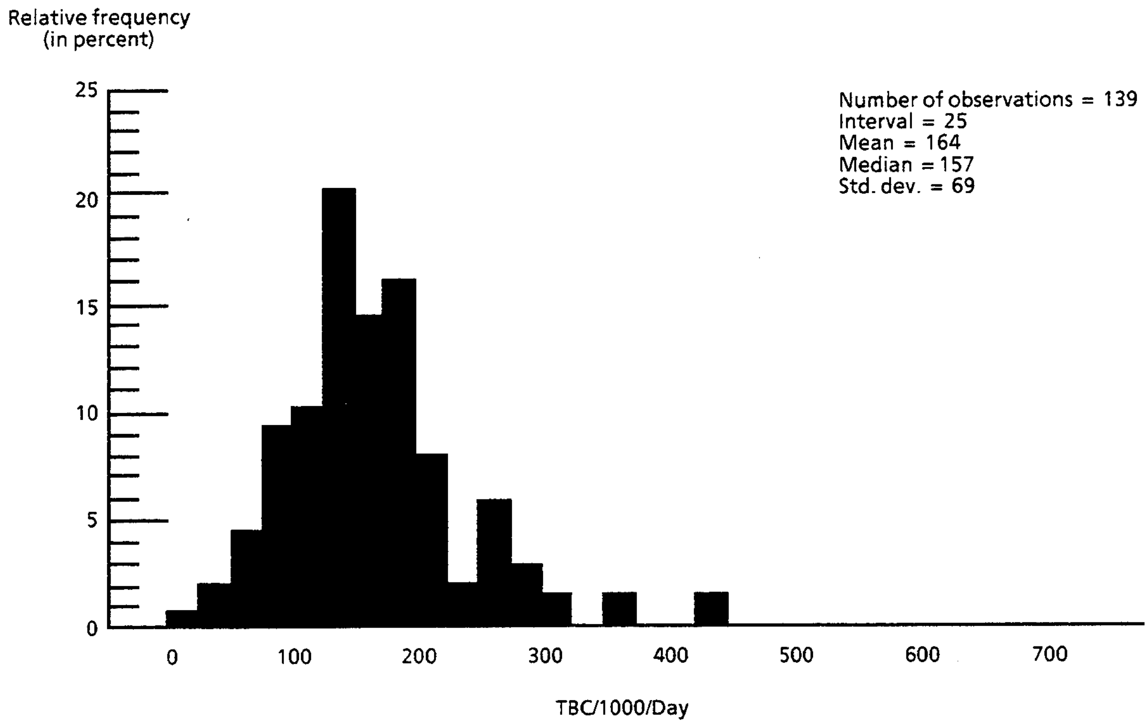
TABLE 10-4

ONE-BATTALION/ONE-DAY
SUMMARY STATISTICS

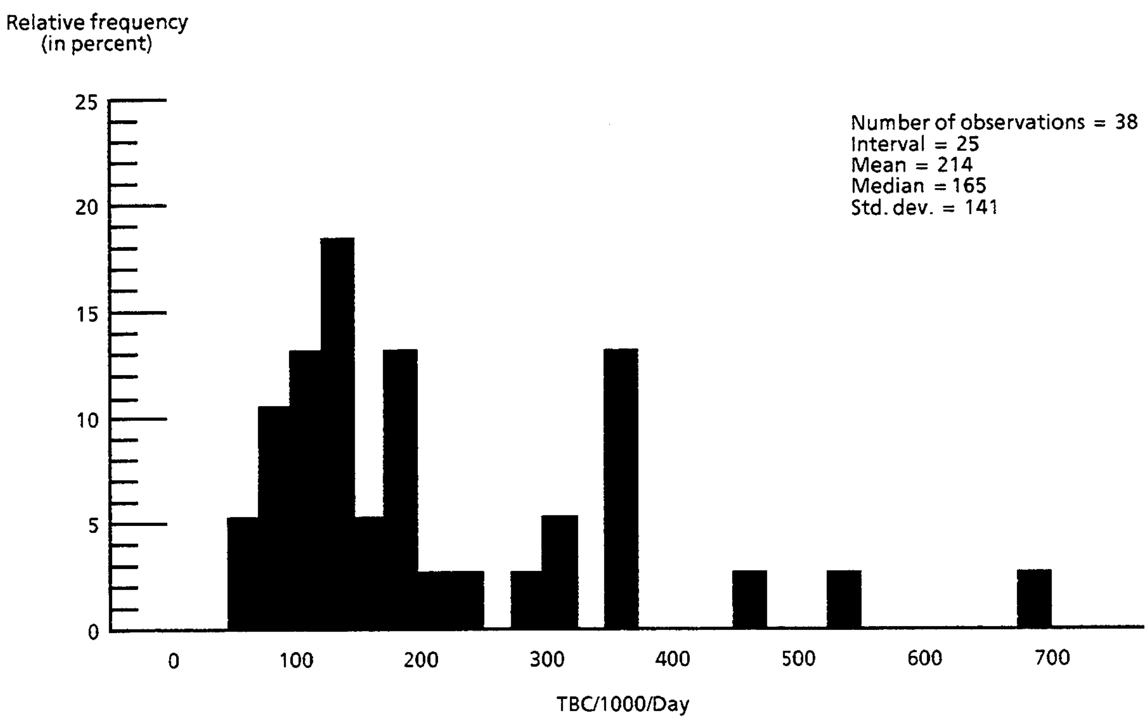
Statistic	NTC	WWII $_{Div \geq 5}$	WWII $_{Div \geq 15}$	WWII $_{Div \geq 20}$
Number of observations	139	51	38	33
Mean	163.74	173.19	214.05	231.16
Standard deviation	69.47	140.51	140.99	143.26
Skewness	0.95	1.64	1.51	1.40
Maximum	449.00	687.07	687.07	687.07
75th percentile	195.00	205.10	308.67	319.73
Median	156.50	132.00	165.00	183.04
25th percentile	123.00	74.90	113.80	132.00
Minimum	24.00	27.39	61.40	83.80

The real-world set of intense combat interactions is marked by a wide range of rates with a significant proportion of extremely high rates. For example, for the case of World War II battalions where the division threshold is ≥ 15 (see Figure 10-7), about 25 percent of the rates are greater than 310, whereas only about 3 percent of the NTC rates exceed that value. Since the World War II subsets are nested, raising the division threshold rate to 20 further separates the two frequency distributions (see Figure 10-8). Yet, even when the division threshold value is lowered to ≥ 5 [where the World War II median is slightly smaller than that for the NTC (132 versus 156.5)] the separation still remains significant at the upper end. (See Figure 10-9.) Yet another view of the distributions is provided by the box plots in Figure 10-10.

The practical distinction between the NTC and World War II data seems clear. The World War II data show generally higher rates. All three subsets of World War II battalion data contain proportionately more of the higher rates than does the NTC data set. This is true even where the World War II data included battalion actions drawn from divisions with casualty rates as low as 5/1000/day, a rate far lower than would be expected for a division in the NTC scenario.



NTC (Undiscounted)



SELECTED WORLD WAR II (Div ≥ 15)

FIG. 10-6. HISTOGRAMS OF BATTALION CASUALTY RATES FOR NTC AND WORLD WAR II (Div ≥ 15)

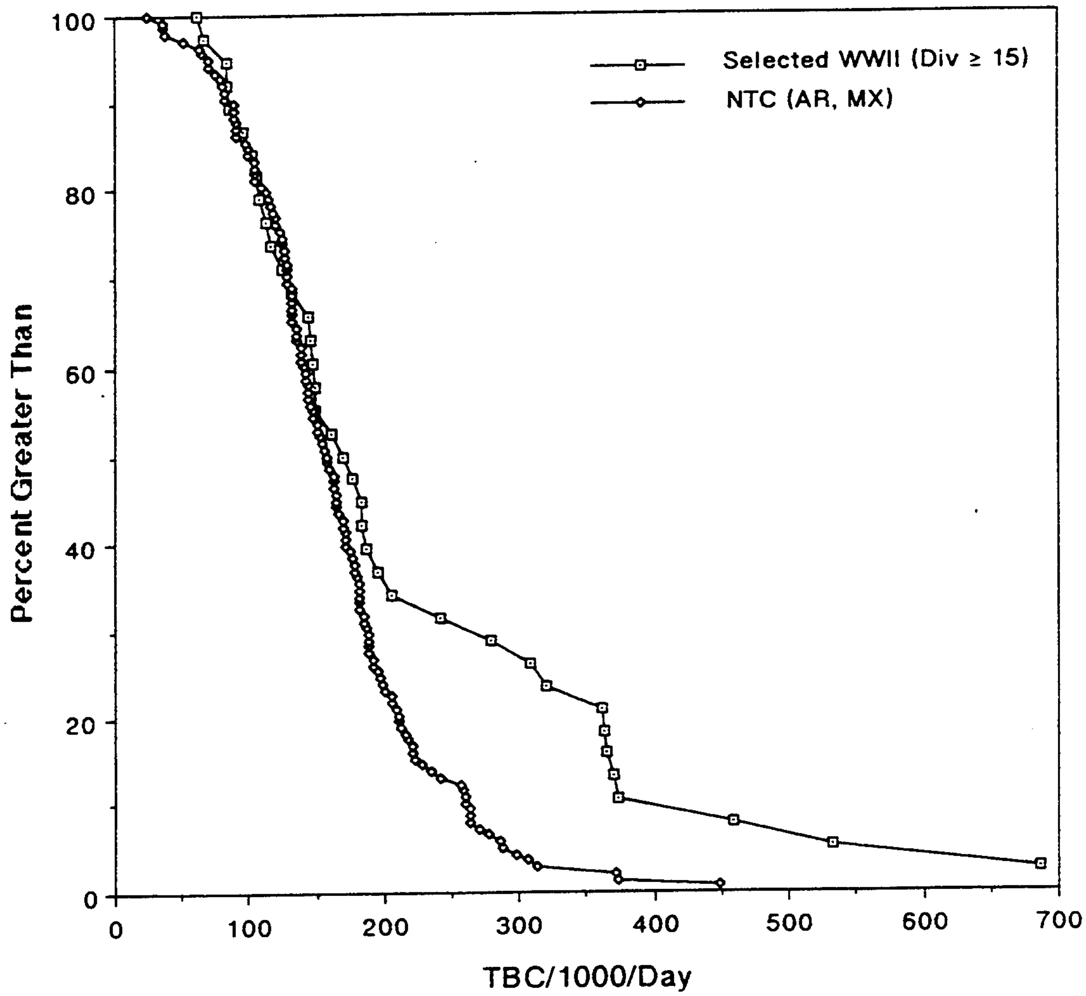


FIG. 10-7. SURVIVOR CURVES OF NTC VERSUS WORLD WAR II (Div ≥ 15)

The statistical tests we performed (see Appendix G) show the NTC rates are not higher on average than the World War II rates. Only the case for World War II battalions drawn from divisions with rates ≥ 5 shows even a marginally significant difference; but the difference is inconclusive since the NTC median is higher (156 versus 132) while the World War II mean is also higher (173 versus 164). The other two cases (for World War II battalions drawn from divisions with rates ≥ 15 and ≥ 20) show, respectively, no significant indication the NTC rates are higher and highly significant indication the World War II rates are higher.

Recognizing that the test employed is insensitive to extreme values in the tails of the distributions being examined, we believe it is safe to conclude that NTC training data as recent as 1988 offer no empirical evidence whatever that U.S.

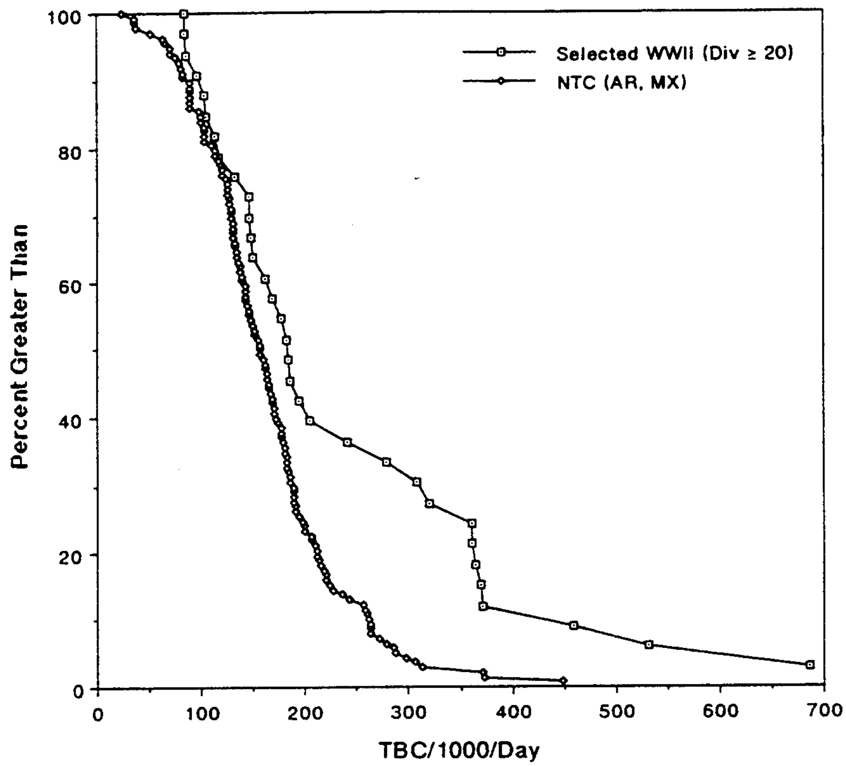


FIG. 10-8. SURVIVOR CURVES OF NTC VERSUS WORLD WAR II $_{(Div \geq 20)}$

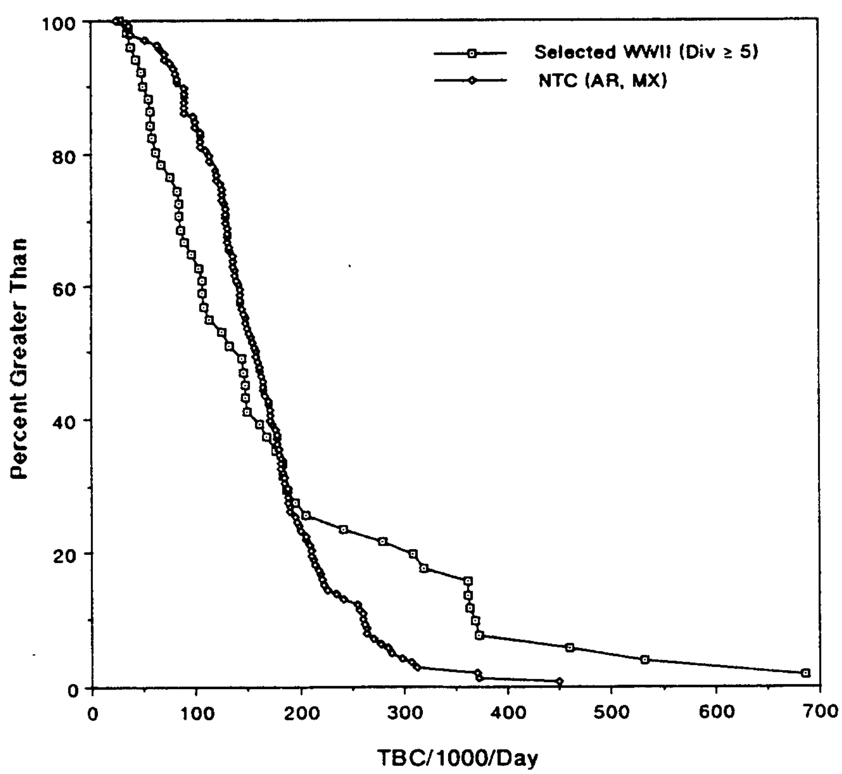


FIG. 10-9. SURVIVOR CURVES OF NTC VERSUS WORLD WAR II $_{(Div \geq 5)}$

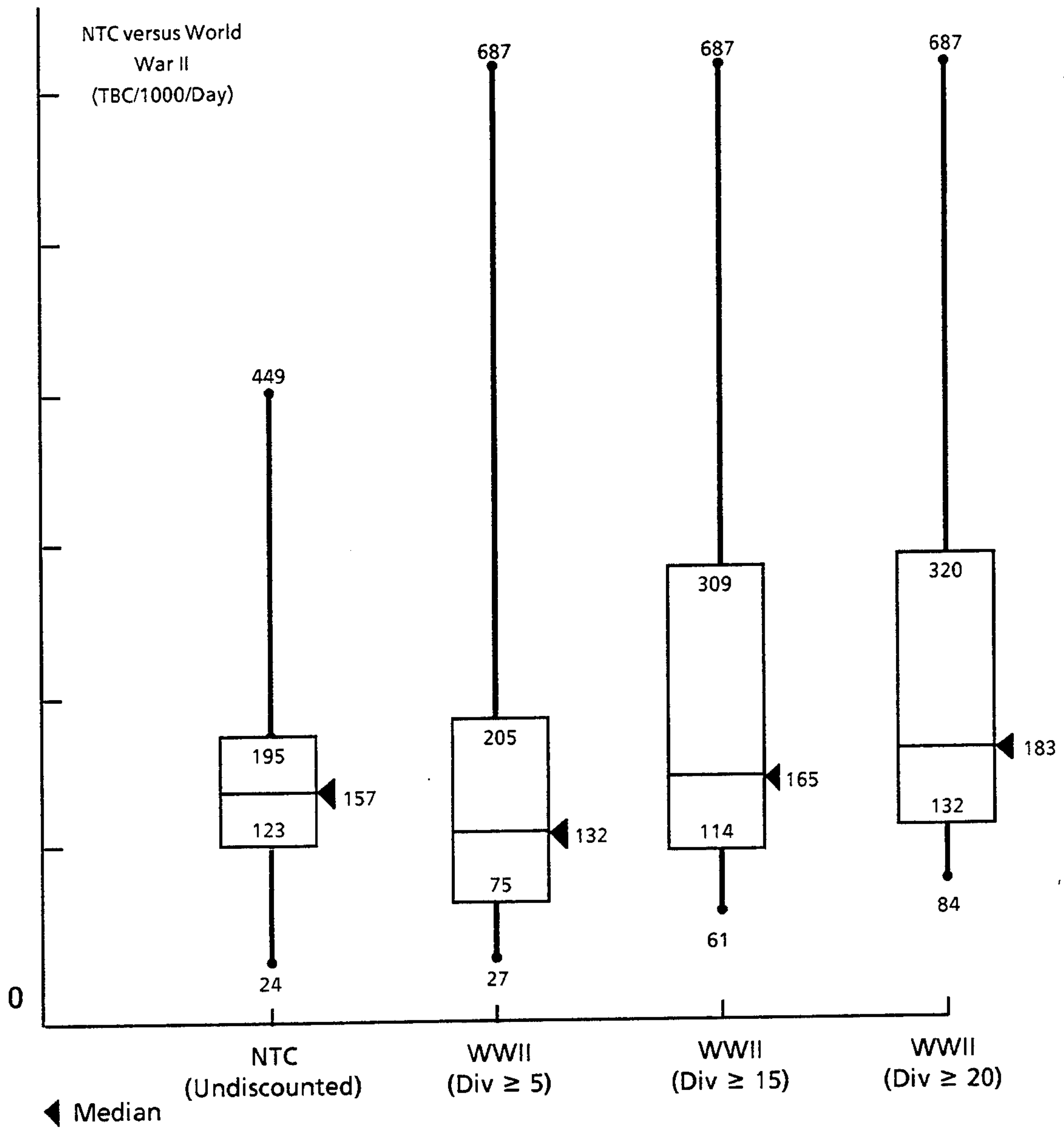


FIG. 10-10. BOX PLOTS OF NTC AND WORLD WAR II BATTALION CASUALTY RATES

casualty rates in clashes between U.S. and Soviet-style forces are higher at the battalion level than rates seen for battalions in World War II.

This result is not what we expected to find, given the widespread sense that the NTC represents worst-case battalion casualty experiences. We suspect many have forgotten how high actual combat casualty rates in modern warfare have been, and what even relatively "low" rates may entail both operationally and to the combatants who experience them. Our World War II data, for example, do not include battalions from those divisions that sustained the worst casualty rates in World War II.

CHAPTER 11

CONCLUSIONS

Our research indicates that the reasonableness of a projected casualty rate may be determined, within bounds, by assessing the pattern(s) it described or assumes. The reasonable casualty rate should reflect the characteristics of casualty rate patterns as demonstrated in actual combat.

This reflection may be in the form of a direct correspondence of the projected rate to those characteristics: showing daily values that fluctuate dramatically between high and low points appropriate for the force size, time period, and general setting. A projected rate that thus explicitly exhibits the rate pattern characteristics results from a model that simulates the detailed course of combat over time – thus the course of casualty rates that may be observed as model products.

Alternatively, the rate may represent an average, as in the case of simpler projection methods that merely assign a given rate number to a force for some time period. In these cases the patterns the assigned rate represents are of course only implicit. But if the average rate is realistic it must comprehend the set of daily rate possibilities we know from the empirical patterns to be implicit in such an average. These rate possibilities would include, again, both the degree of daily rate fluctuations inherent in such an average, and the set of high and low values those fluctuations would likely encompass.

Such evaluations are possible because casualty rates occur in patterns that can be characterized both quantitatively and qualitatively. The empirical evidence shows that rates at every echelon exhibit both daily pulses and multiday clusters of pulses, that the variability of daily rates is dramatic even at higher echelons, that multiday pulses tend to be distinct (separate in time) from one another, and that the magnitude and duration of the pulses are associated. The evidence also indicates major conditions associated with rates. These begin with the overall scenario (e.g., an operational versus a strictly tactical scenario; a continuous versus a disrupted front) and reach to conditions associated with scenario (e.g., magnitudes of 10-day total battle casualty rates; proportion of wounded to TBC rates).

Further, the evidence shows that, given the same general combat context, forces encountering Soviet-style forces and operational methods do not face higher casualty rates than did U.S. forces facing German opponents in World War II. This is clear from data on German rates at the division level sustained during some of the classic Soviet operations of that war, and from data on U.S. battalion rates (undiscounted) sustained at the Army's National Training Center in the mid- to late-1980s.

CONCLUSIONS

We conclude the following about current U.S. Army and U.S. Marine Corps battle casualty rate projections for the European scenario.

U.S. Army

With reference to the two major casualty rate projections (WARMAPS/POM and OPLAN) for theater divisional forces in the Central Front setting, and assuming a major attack axis into the U.S. sector:

Conclusion 1: The empirical evidence does not support either the magnitude of current peak 10-day period rate projections, or the distribution of 10-day incremental rates over the full time line of 90 or 180 days.

Conclusion 1(A): The magnitudes of currently projected peak rate periods may be too high by a factor of about 1.5 to 2.0.

These conclusions assume that the U.S. frontage of the NATO central front remains continuous, maintaining its basic integrity even though possibly sustaining major pullbacks of the front line in certain sectors. If, to the contrary, we assume that the U.S. sector is disrupted, the Army's current peak rate projections are supported by the empirical evidence, and the possibility is these peaks could reach even higher.

An important qualification is that if sufficient rationale exists outside the empirical evidence that army 10-day rates would probably be as high as projected even within a continuous front, then the daily rates for individual divisions that comprise the overall army rate should at least reflect the kinds of patterns implicit in the average. For example, particular divisions in the force should include peak daily rates that are unusually high (though within the range seen empirically), offset by a number of low daily rates (possibly in the range of 5 – 10/1000/day if not less). That is, a mean rate for an army-size force that is higher than what the empirical evidence would support for a given scenario should at least behave in a patterned manner – in pulses with the associated variability – consistent with the empirical evidence of combat.

Conclusion 1(B): The distribution of peak rates ought to show multiple peaks, separated by increments of lower rates, if the assumption is that significant combat will persist for as much as 60 days. The projection of only one 10-day peak in a period of 60 to 90 days of combat is unrealistic.

This second conclusion also assumes the U.S. sector and indeed the entire NATO central front remain continuous. However, the possibility that only a single peak will be sustained grows significantly if disruption should occur, due largely to the fact that in this circumstance combat beyond 30 days may be problematic.

Conclusion 2: The empirical evidence shows that the currently projected distribution of casualties by type (wounded versus other) does not reflect the changed proportions of types associated with different major scenarios. In particular, the proportion of the WIA rate to the total battle casualty rate should reduce by as much as half that currently projected (i.e., to a level of roughly 30 to 40 percent) when a 10-day peak period describes one of two scenarios:

- **The force is on the defense, taking heavy casualties and losing ground rapidly, but the front remains continuous.**
- **The force experiences a disrupted front.**

U.S. Marine Corps

The Marine Corps currently uses the same rate numbers (battle casualties per 1000 strength per day) in two separate casualty projection methodologies. These support (1) the OPLANs and (2) the WARMAPS process.[1] However, the rate values are assigned for time periods of different duration and to portray rates for differently sized populations at risk in the two methodologies.

[1]Marine Corps rate projections and projection methodologies are now under review.

With reference to the OPLAN approach:

Conclusion 3(A): The empirical evidence supports the currently defined magnitude for a peak period rate.

This conclusion is qualified by considerations of force size and of the sector represented. Those factors are classified, so discussion of the qualifications is found in the Classified Supplement.

Three remarks may be made. First, the rate assumes the Marine Corps' portion of the sector front remains continuous. If disruption were to occur, either in the Marine Corps' portion or elsewhere in the sector, the rate could increase significantly for the designated time period. Second, it is significant that the force represented is not of the size contemplated in Army force calculations. The empirical data are clear that as force size decreases both the average rate over time and its associated daily variability for a given "hot spot" will increase. Thus, the rate for this force will probably be higher, assuming the force occupies a comparably "hot spot" for a relatively brief peak period, than the average rate across an Army force of, say, 10 to 15 divisions given its own such hot spot and over the same period. The rate of the smaller force is also, because of its inherently greater variability, more difficult to project. Finally, it is important that the full rate here applies only to the combat personnel of the engaged ground force element. (The rate described for the full ground force on the combat line – which can be determined by combining rates-against-population calculations for the force's combat and support components is also supportable.)

Conclusion 3(B): The evidence does not support the projection's designation of only one peak period over the full time line.

This conclusion assumes that the full time line contemplates combat that is significant and not light or sporadic. As in 1.B (Army) above, a time line that reaches to some point significantly beyond 30 days, assuming significant combat continues, will display multiple peaks. On the other hand, if the assumption is that combat will be light or sporadic, the current projection beyond the peak period may be supportable.

With reference to the WARMAPS approach:

Conclusion 4(A): The empirical evidence does not support the projected peak rate over the full Marine Corps' theater force for a 10-day period.

A simple number cannot be assessed as a reasonable casualty rate if it is taken to apply to any force size over any time increment and scenario. The evidence is clear that rates are strongly dependent on force size, time, and sector (scenario). The procedure currently used by the Marine Corps to translate the perceived operational picture and its casualty rates into the WARMAPS framework fails to take into account the fact that as force size (population at risk) and time increment change, the applicable rate for a given scenario must also change if it is to be considered reasonable. In other words, a rate that is reasonable for a given force size in a given time period and sector will be unreasonably high if applied against a sufficiently larger force over a sufficiently longer time period when, still, only the same-sized portion of the force is set into the particular sector driving the rate.

Conclusion 4(B): The distribution of peak rates over the full time line is not supported by the empirical evidence, for the same reasons as in 1.B. (Army) and 1.B. (Marine Corps), and similarly qualified.

CHAPTER 12

MODEL REPRESENTATIONS OF CASUALTY RATES FIRST INDICATIONS

We may already have some insight into why current U.S. Army WARMAPS and POM projections are so much higher (as theater 10-day averages) than anything seen empirically for the scenarios envisioned. Figure 12-1 contrasts the daily rates of an actual division in combat to the daily rates of one division as represented in a recent model simulation of combat in Europe.

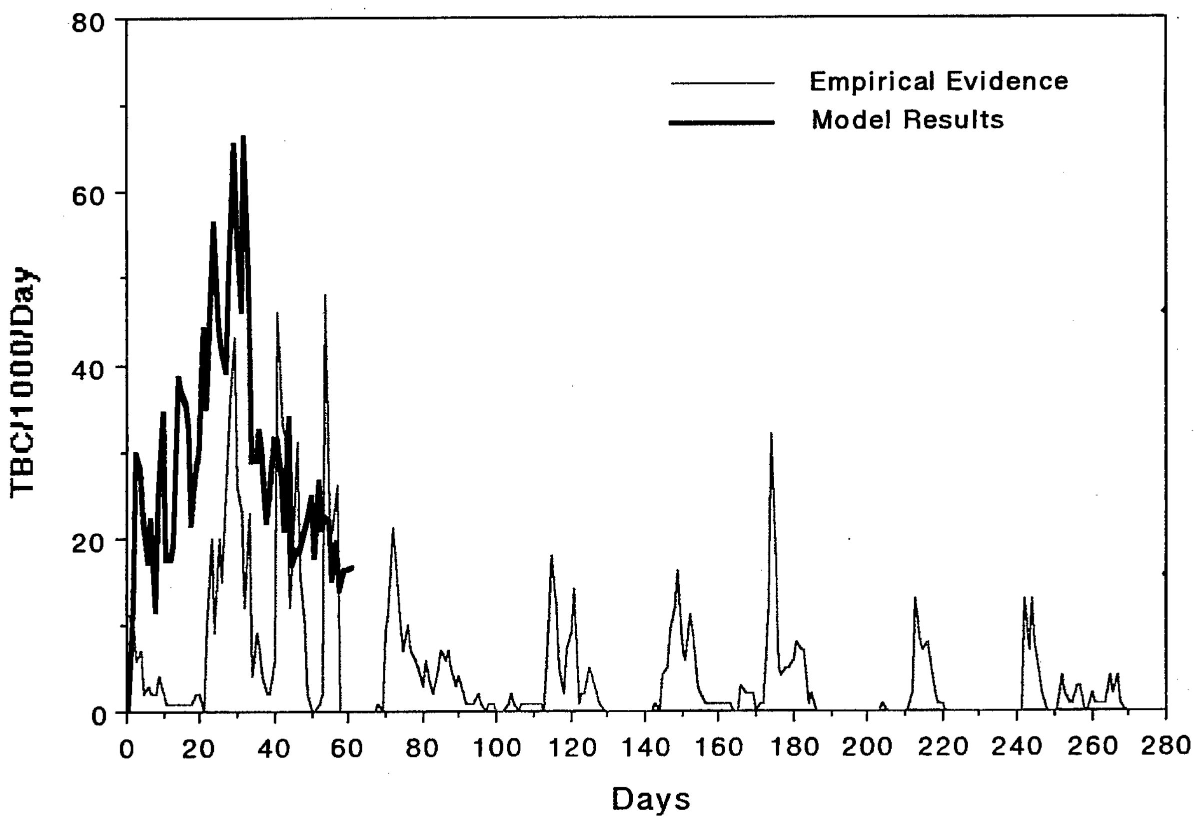


FIG. 12-1. MODEL REPRESENTATION VERSUS EMPIRICAL EVIDENCE OF DAILY CASUALTY PATTERNS FOR DIVISION-SIZE FORCE

We again take the 30th Infantry Division from the 12th Army Group data to illustrate the kind of pulsing (both daily and multiday pulses) and the kind of daily variation in rates the empirical record shows real divisions may experience. The modeled division represents one U.S. division's experience in the Omnibus-89 European simulation.[1] The comparison focuses not on the two divisions' particular rates as much as on the *patterns* of the two sets of rates.

The contrast speaks for itself. The model's representation of a high average division rate does not indicate realistic daily pulses and variability. The division fails to experience peak daily rate pulses nearly as high as would be warranted by its high average rate over any given 10-day block, much less over a full 60 days. The same is true of the lack of low rates. In short, the division exhibits a high average rate without the daily variability of high and low rates that would reasonably be associated with such an average.

Many have voiced suspicions over the years that mathematical models overstate the pace and intensity of combat. If this one division's rate curve is representative of the model's treatment of divisions and higher echelon forces generally – more work is necessary to establish whether this is so – we begin to see what may be the foundation of the Army's modeled rate projections.

Figure 12-2 contrasts the five highest 10-day rates sustained by any U.S. army during World War II to the six 10-day rates sustained by the army-size U.S. divisional force in Europe in the model simulation.

Both the model rates and the historical rates describe scenarios where the front remains continuous. The model's 10-day average rates are in effect all peak rates, most of them markedly higher than the worst seen in actual combat. Moreover, the model's peak rates also occur back-to-back, whereas actual combat shows army 10-day peaks to be separated by time intervals, that is, to occur in pulses.

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[1]The model in question is the "Concepts Evaluation Model" (CEM) which has been principally responsible for the Army's casualty rate projections over the past several years. CEM remains in use, though work is apparently nearly complete on its follow-on version, the "Forces Evaluation Model" (FORCEM). The simulation studied is OMNIBUS 89.

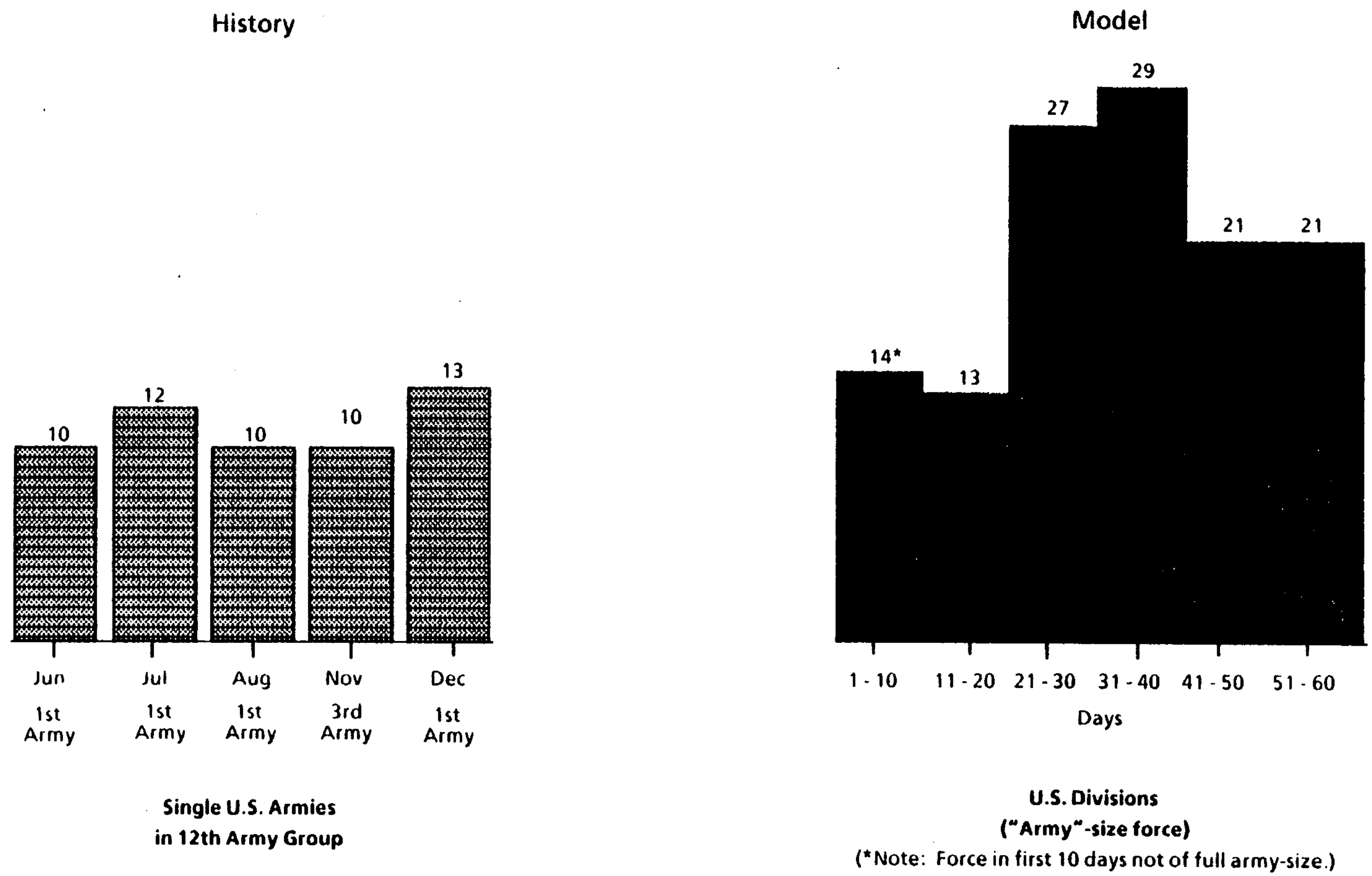


FIG. 12-2. COMPARISON OF HISTORY AND MODEL REPRESENTATION

Army-level 10-day Peak Rates (TBC/1000/day)

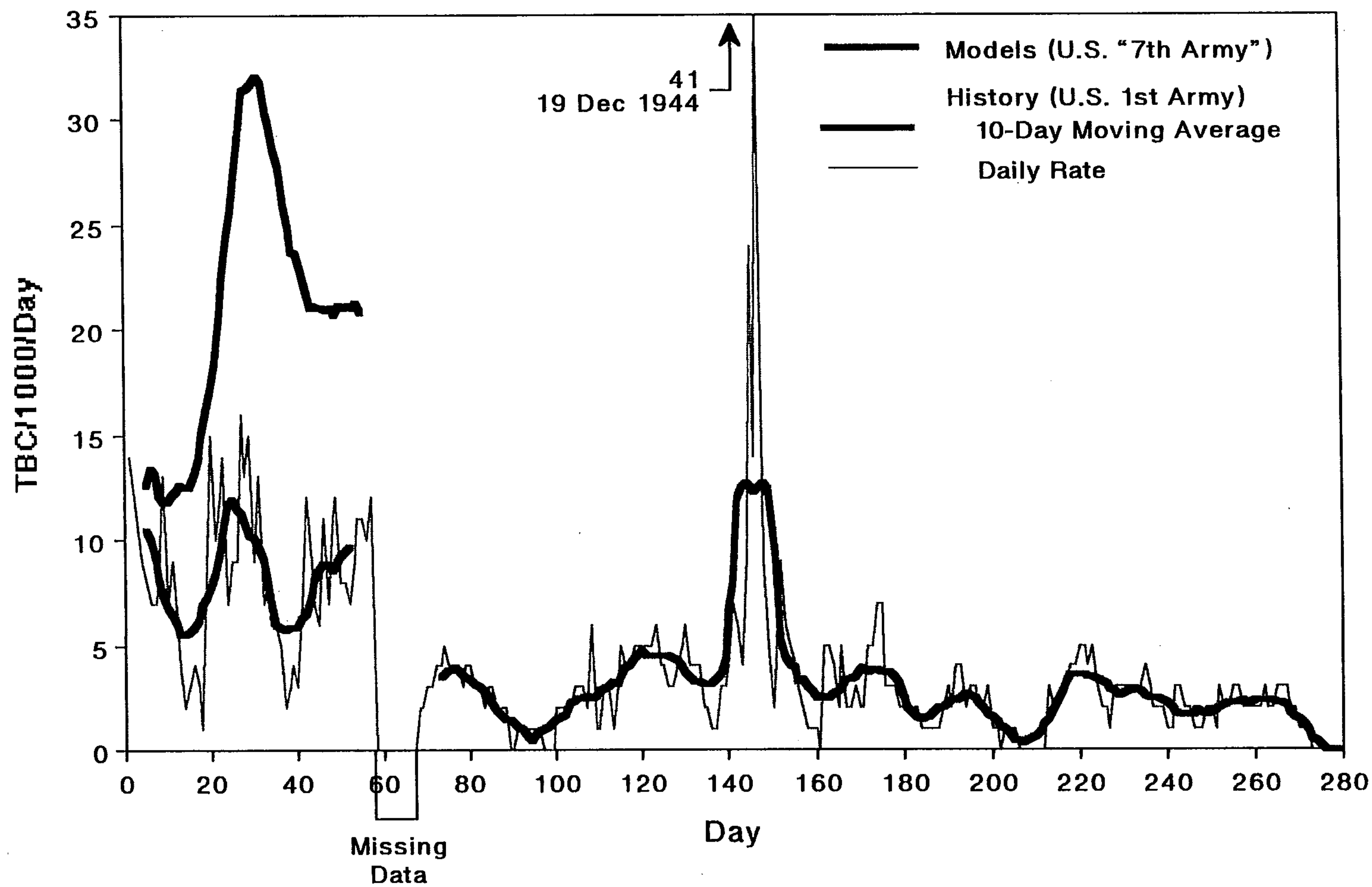


FIG. 12-3. MODEL REPRESENTATION VERSUS EMPIRICAL EVIDENCE OF CASUALTY RATE PATTERNS FOR ARMY-SIZE FORCE

Figure 12-3 provides another perspective on these model results. The figure compares the modeled force's (termed "7th Army") moving 10-day average rate to the U.S. 1st Army's daily rates and 10-day moving average.

We have seen that even classically successful Soviet offensives in World War II that disrupted the German front resulted in German 10-day army-level casualty rates in the vicinity of 20/1000/day. Continuous-front defensive situations appear not to have exceeded an army 10-day rate of 13/1000/day. We have also seen that rates from actual operations subsequent to World War II offer no empirical evidence of higher rates for comparable situations than those seen in that war.

The model's projected army 10-day rate, which assumes a continuous-front scenario, appears highly inconsistent with the way actual combat produces army-level casualty rates.

APPENDIX A

CLASSIFIED SUPPLEMENT

APPENDIX A

CLASSIFIED SUPPLEMENT

This supplement briefly illustrates and discusses projected casualty rates supporting Operations Plans (OPLAN) for U.S. Army and U.S. Marine Corps divisional forces in Europe.

The supplement is classified SECRET and is available upon request to the Director of Mobilization Planning and Requirements, OASD(FM&P), Room 3D-826, The Pentagon, Washington, D.C., 20301-4000.

APPENDIX B

12th ARMY GROUP DATABASE

APPENDIX B

12th ARMY GROUP CASUALTY RATES

The following time series graphs show total battle casualty rates per 1000 personnel strength per day. Casualties include all killed, wounded (out of division control for 24 or more hours), captured and missing. Casualties are divided by assigned strength.

These graphs are arranged by echelon (army; corps; division) and by organization or unit number. Army and corps graphs show the day's average (mean) casualty rate for all divisions under that echelon's control. Nondivisional personnel (organic or attached to the echelon) are excluded from tallies of casualties and strength.

We have set the graphs' ordinates at 25/1000/day for armies and at 50/1000/day for corps and divisions. Rates exceeding those levels are marked individually for each such instance.

Note that the 12th Army Group records contain four data gaps: 16 June 1944, 3 and 6 July 1944, and the period 11 August – 30 September 1944. The graphs do not show the three 1-day gaps, as LMI has imputed a casualty rate value to each in order that the rate curve not appear to contain three drastic dips to "0" when in fact the problem is only one of missing data. Of course, it is impossible to know the actual casualty rate for the missing days. Lacking any better method, we interpolated a value midway between the rates for the day preceding and the day following the missing data. We have left a gap of 10 spaces to represent the period 11 August – 30 September 1944. (A gap fully sized to the 51 missing days would have caused the other available data to be too closely packed to discern many of the variations.)

The time line in Figure B-1 matches that of the X-axis in each graph. Data of particular interest (and associated X-value): 15 June 1944 (1), the data begin; 10 August 1944 (57), last day of data before data gap; data gap (58-67); 1 October 1944 (68), first day the data series resumes; 16 December 1944 (144), first day of Ardennes campaign; 30 April 1945 (279), data end.

We include a brief addendum to this appendix (pp. B-75 to B-79) which shows the difference in daily casualty rates for particular divisions between those found in the 12th Army Group records and those found by two other studies.

ARMY GRAPHS

(pages B-5 to B-8)

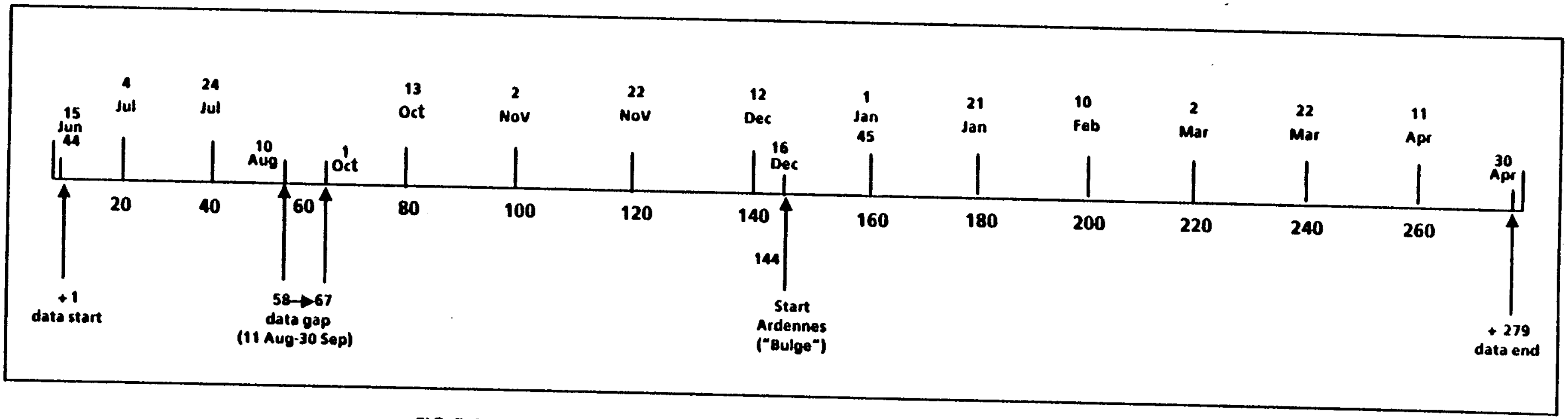
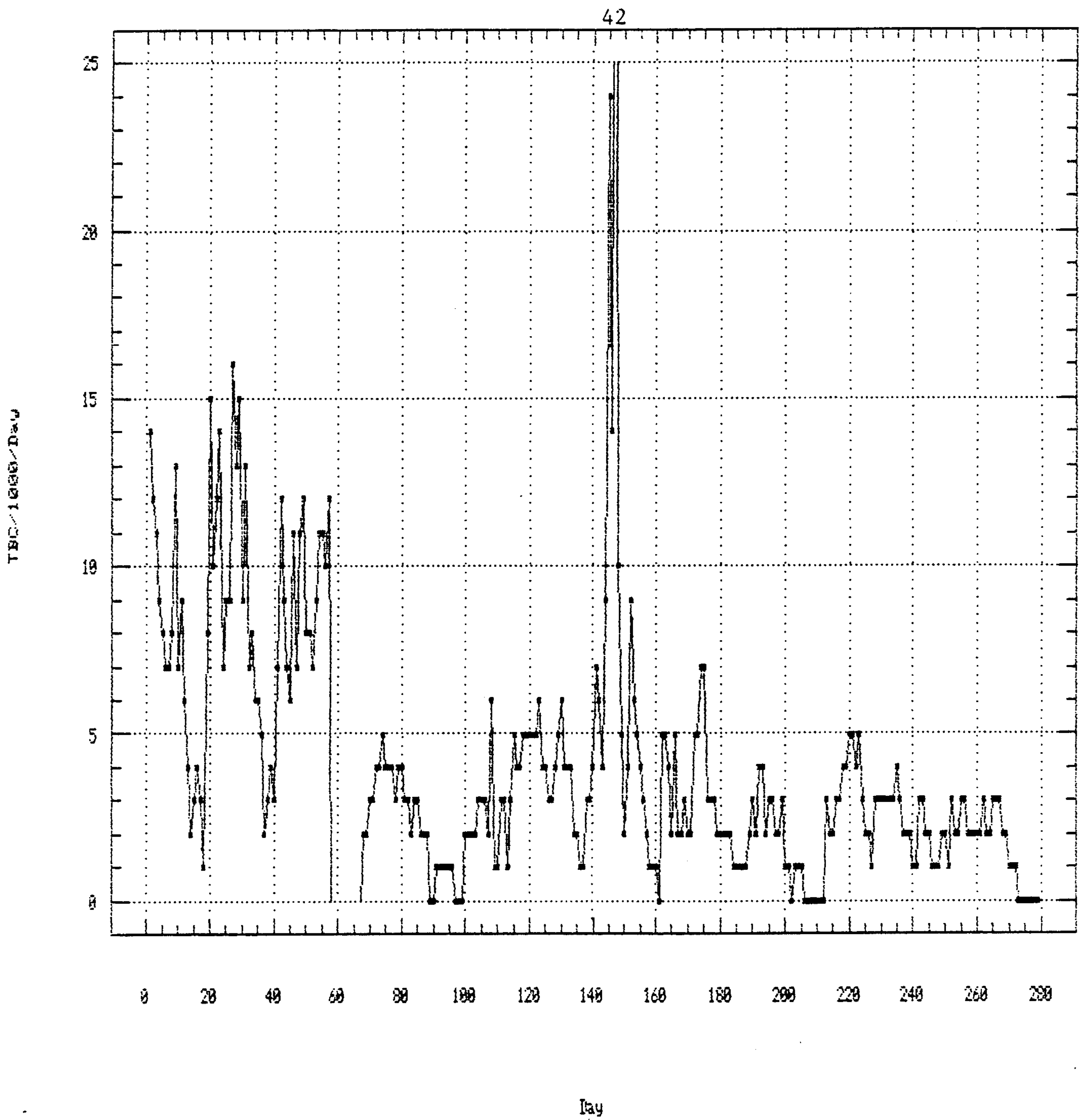


FIG. B-1. TIME LINE USED AS X-AXIS FOR APPENDIX B TIME SERIES RATE GRAPHS

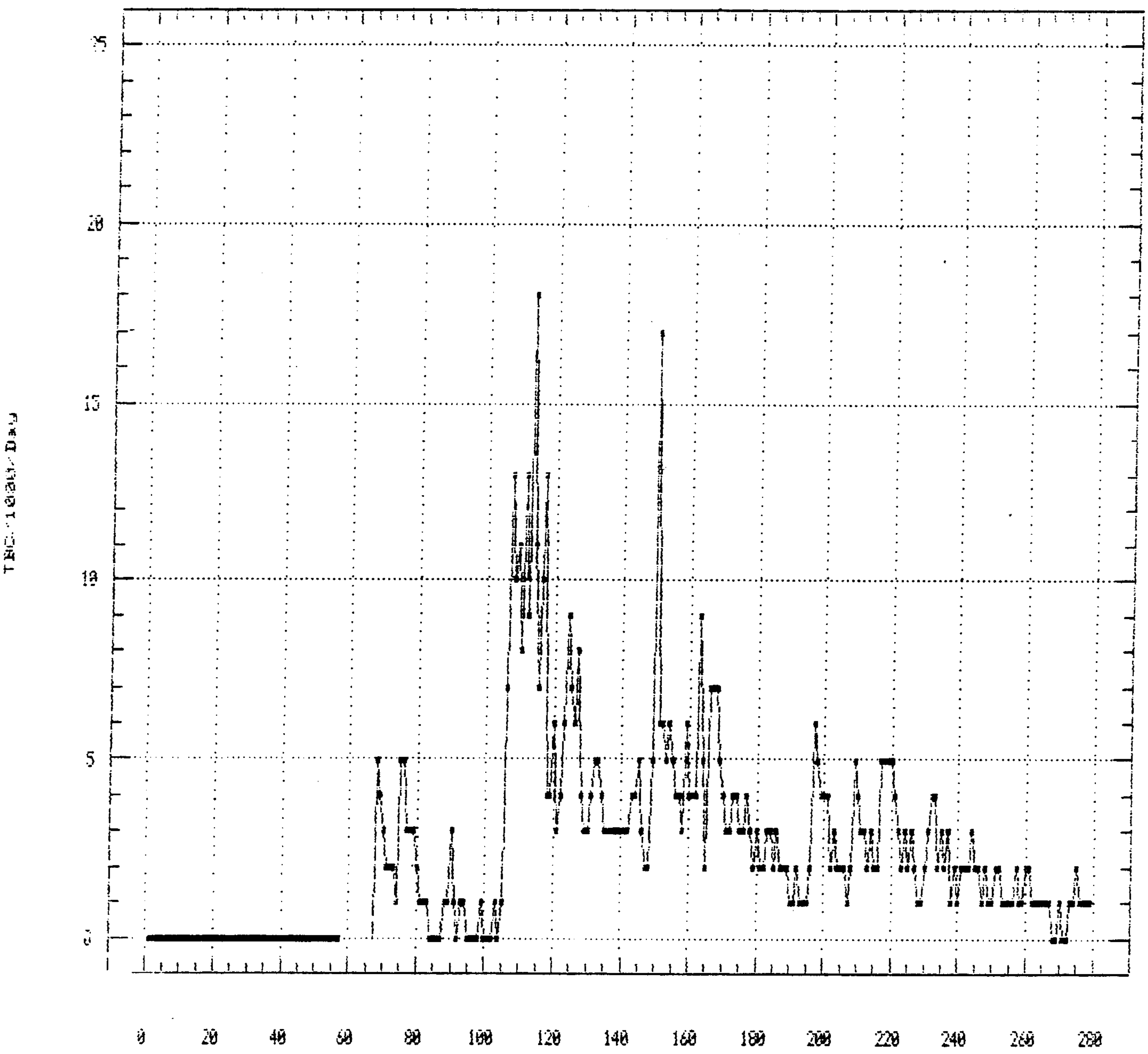
First Army

(Division-level Casualty Rate)



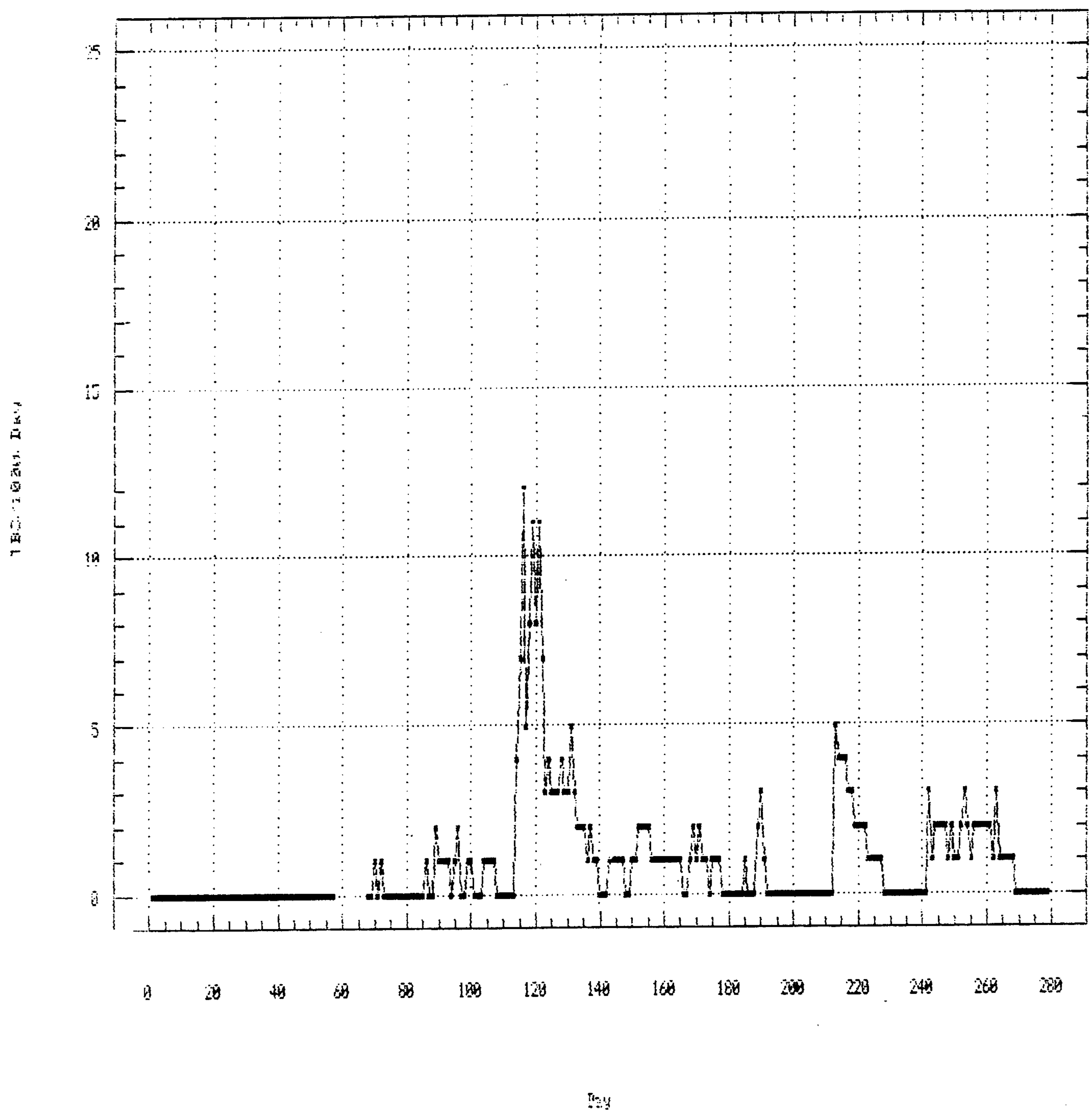
Third Army

(Division-level Casualty Rate)



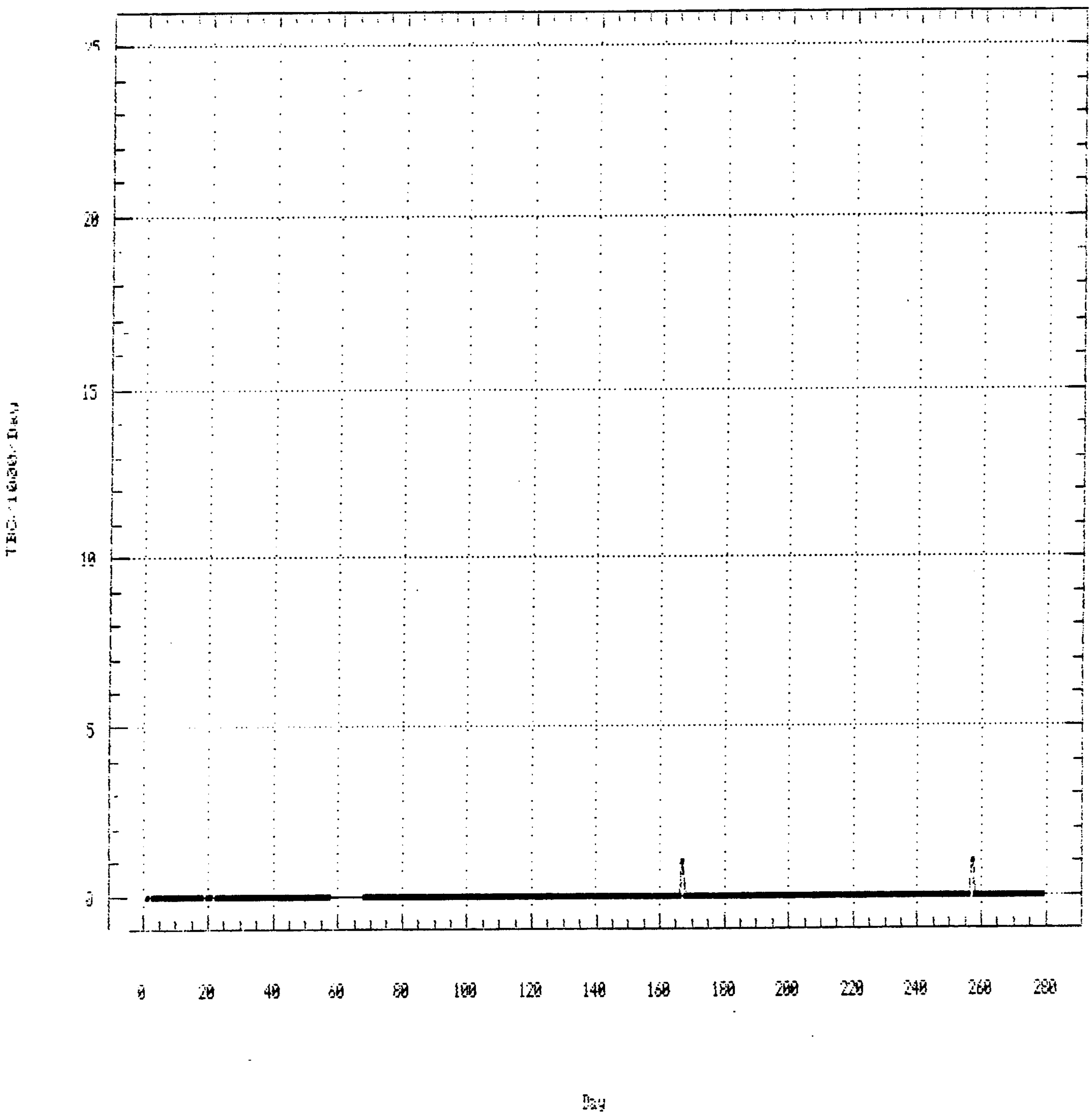
Ninth Army

(Division-level Casualty Rate)



Fifteenth Army

(Division-level Casualty Rate)

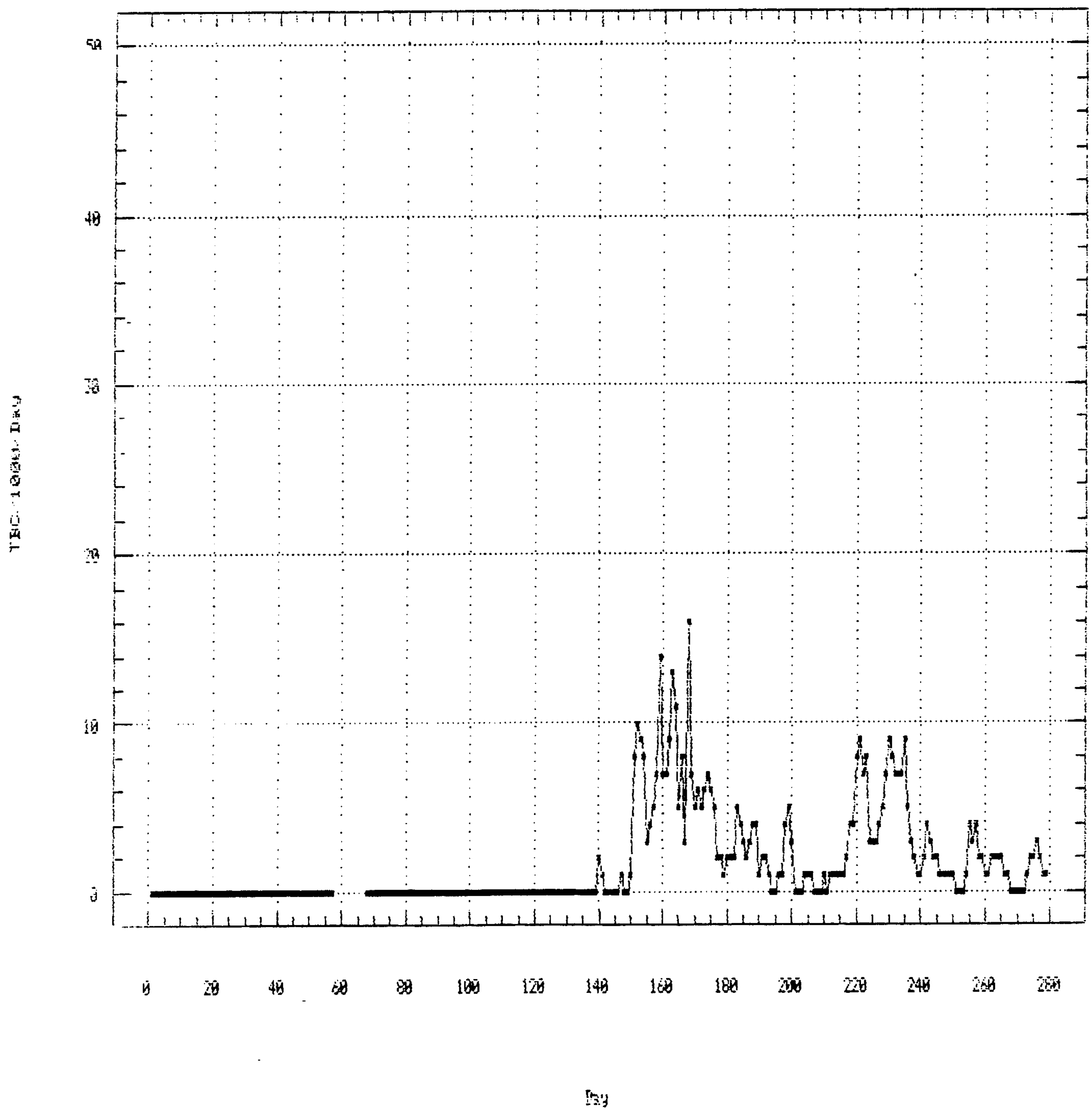


CORPS GRAPHS

(pages B-11 to B-21)

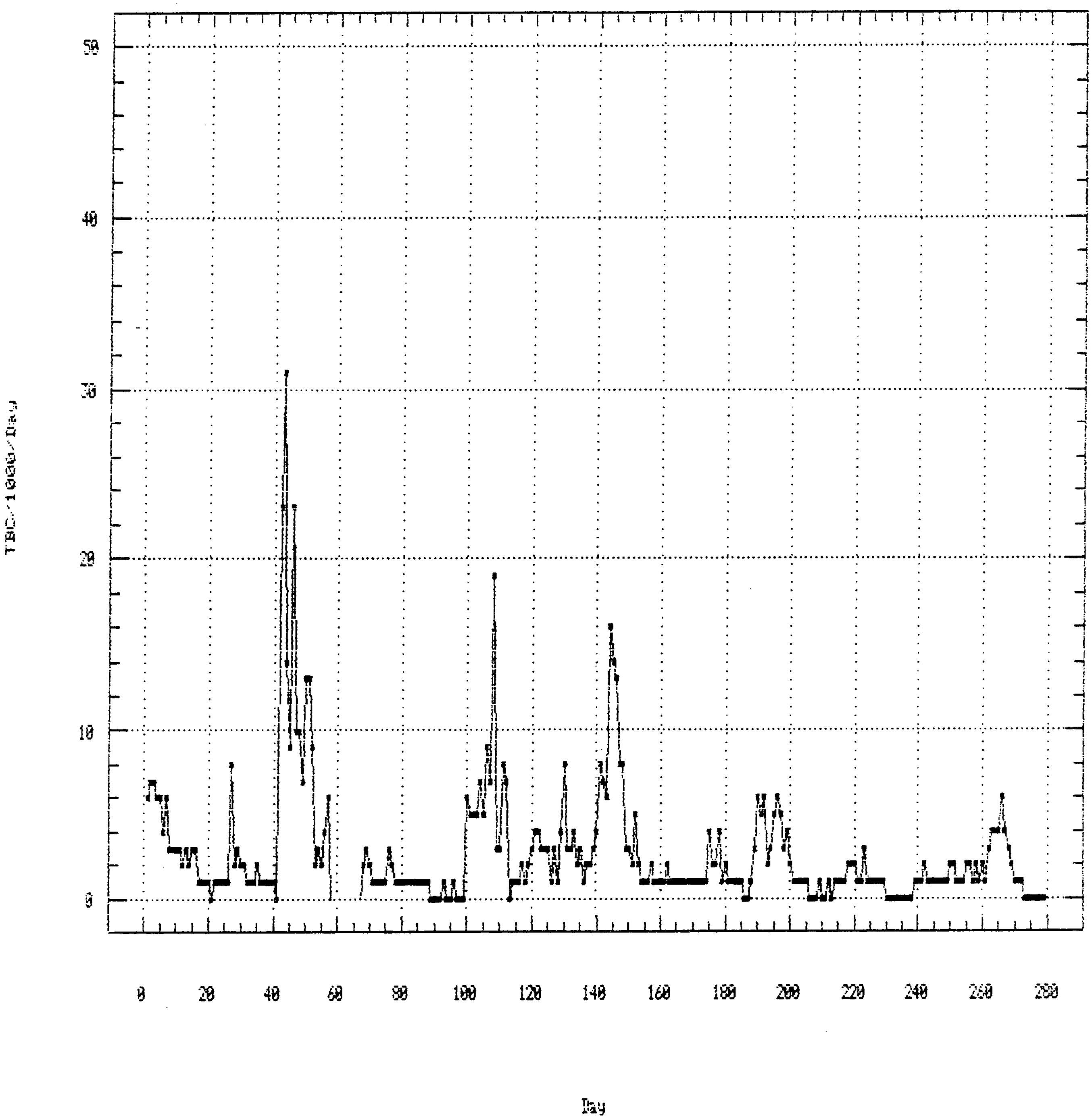
III Corps

(Division-level Casualty Rate)



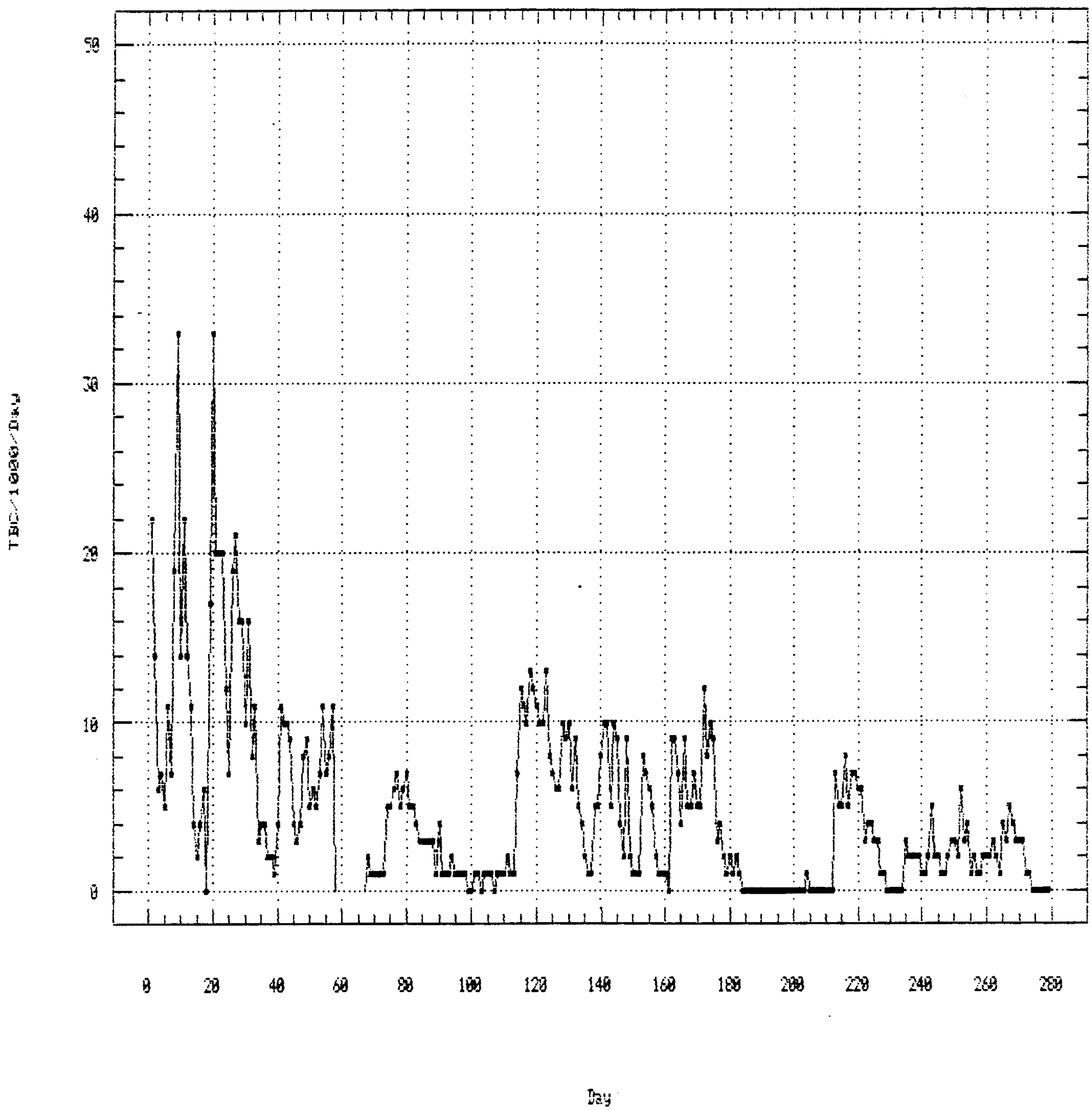
V Corps

(Division-level Casualty Rate)



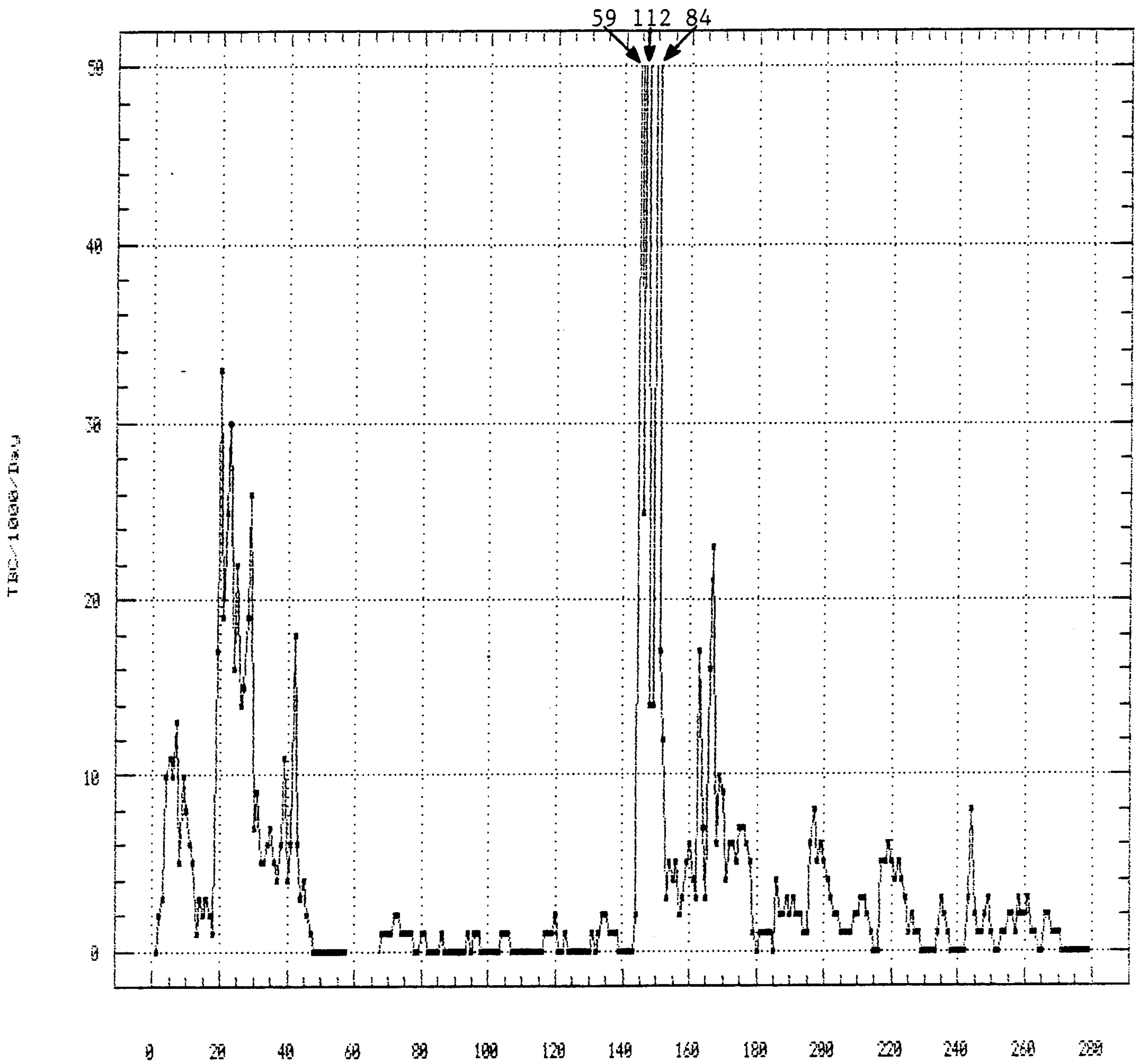
VII Corps

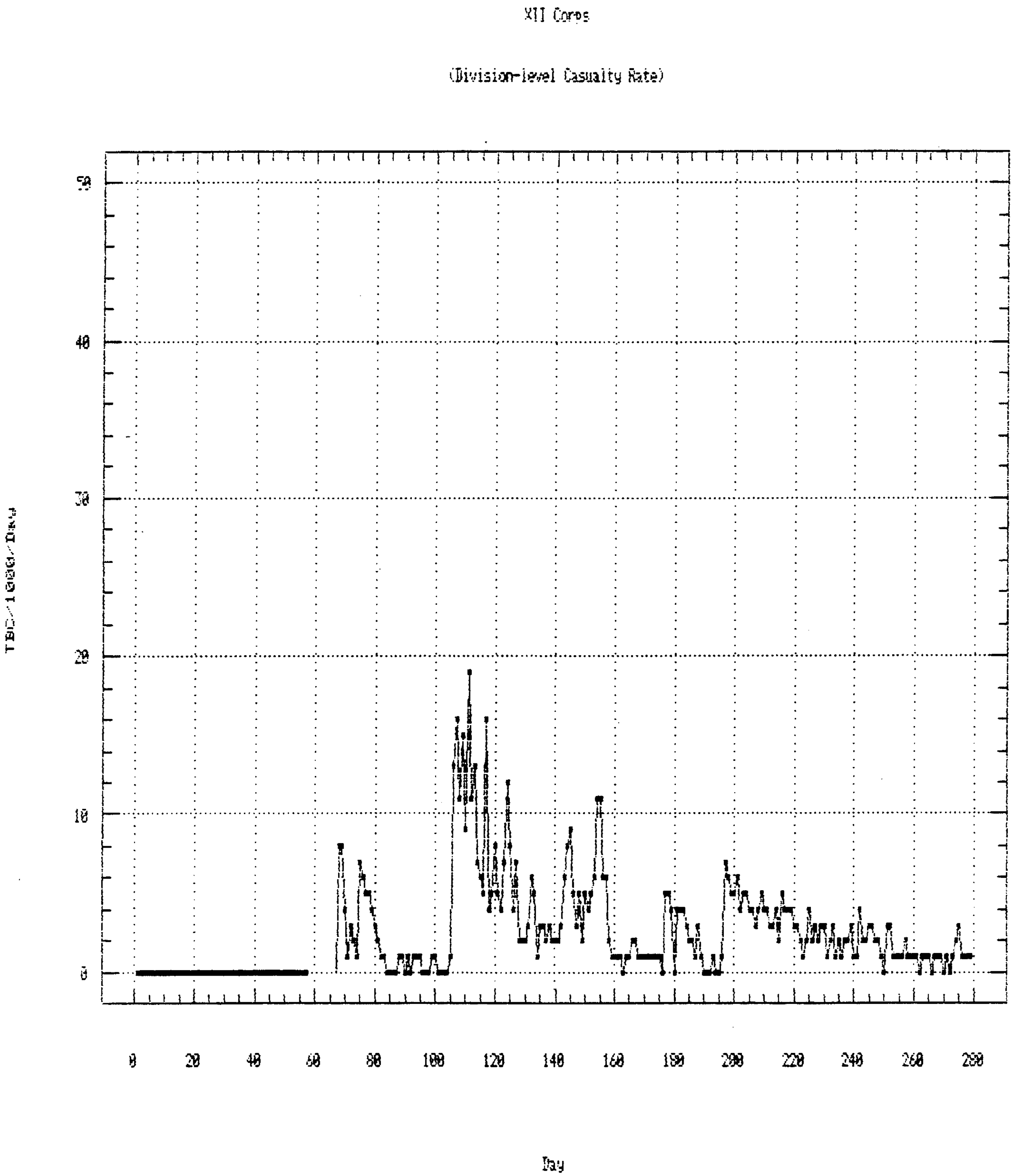
(Division-level Casualty Rate)



VIII Corps

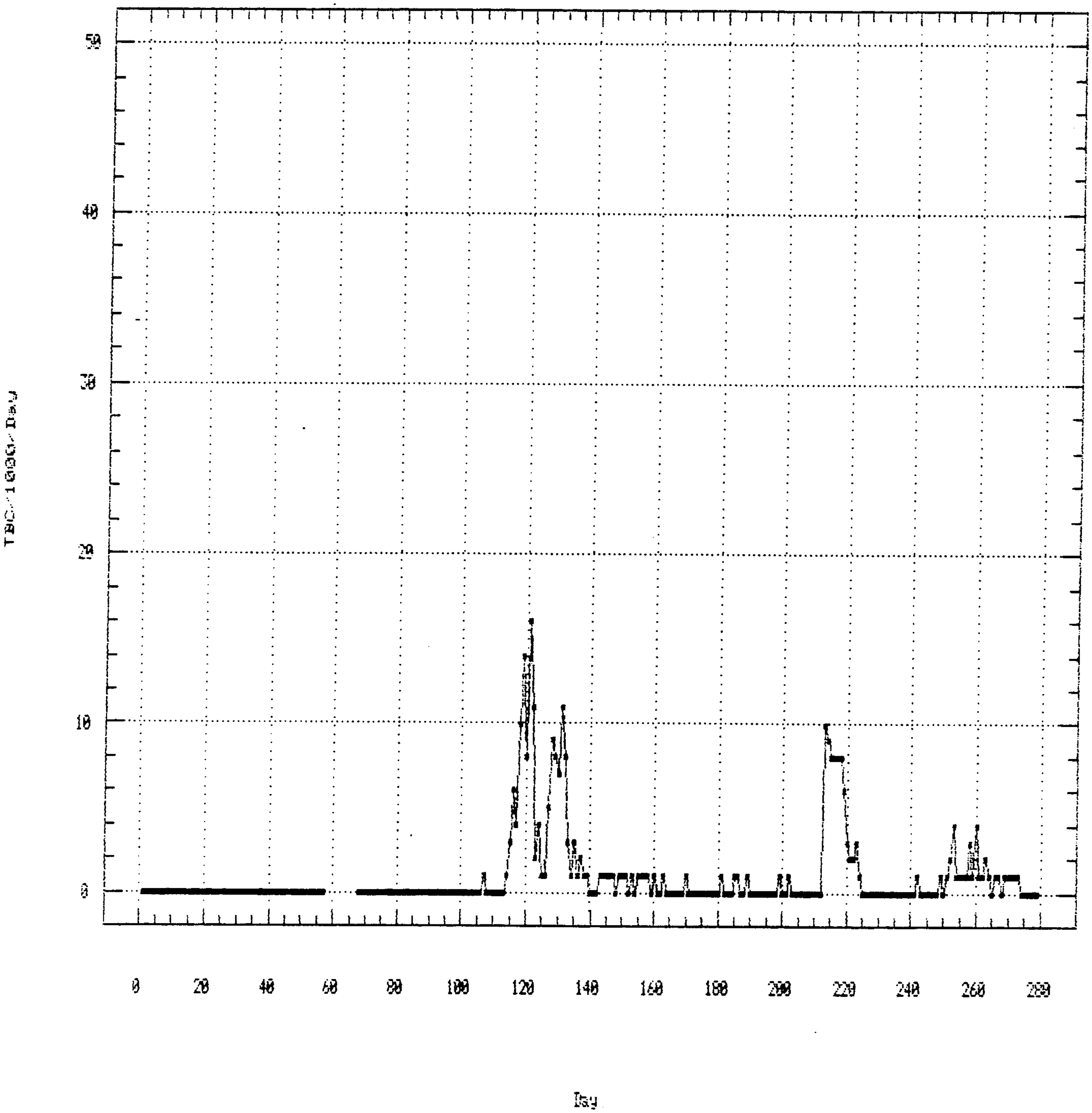
(Division-level Casualty Rate)




XII Corps
(Division-level Casualty Rate)
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

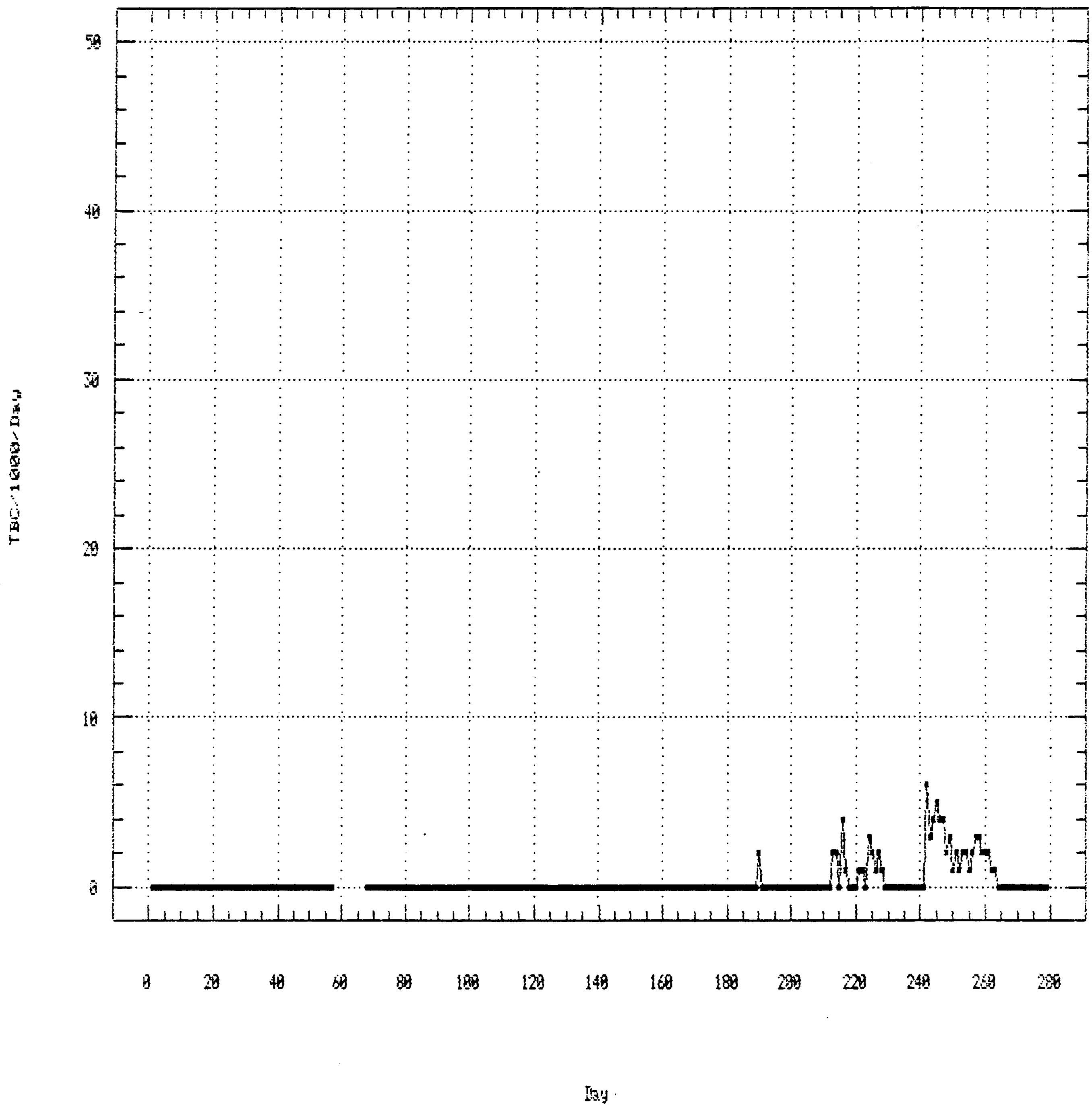
XIII Corps

(Division-level Casualty Rate)



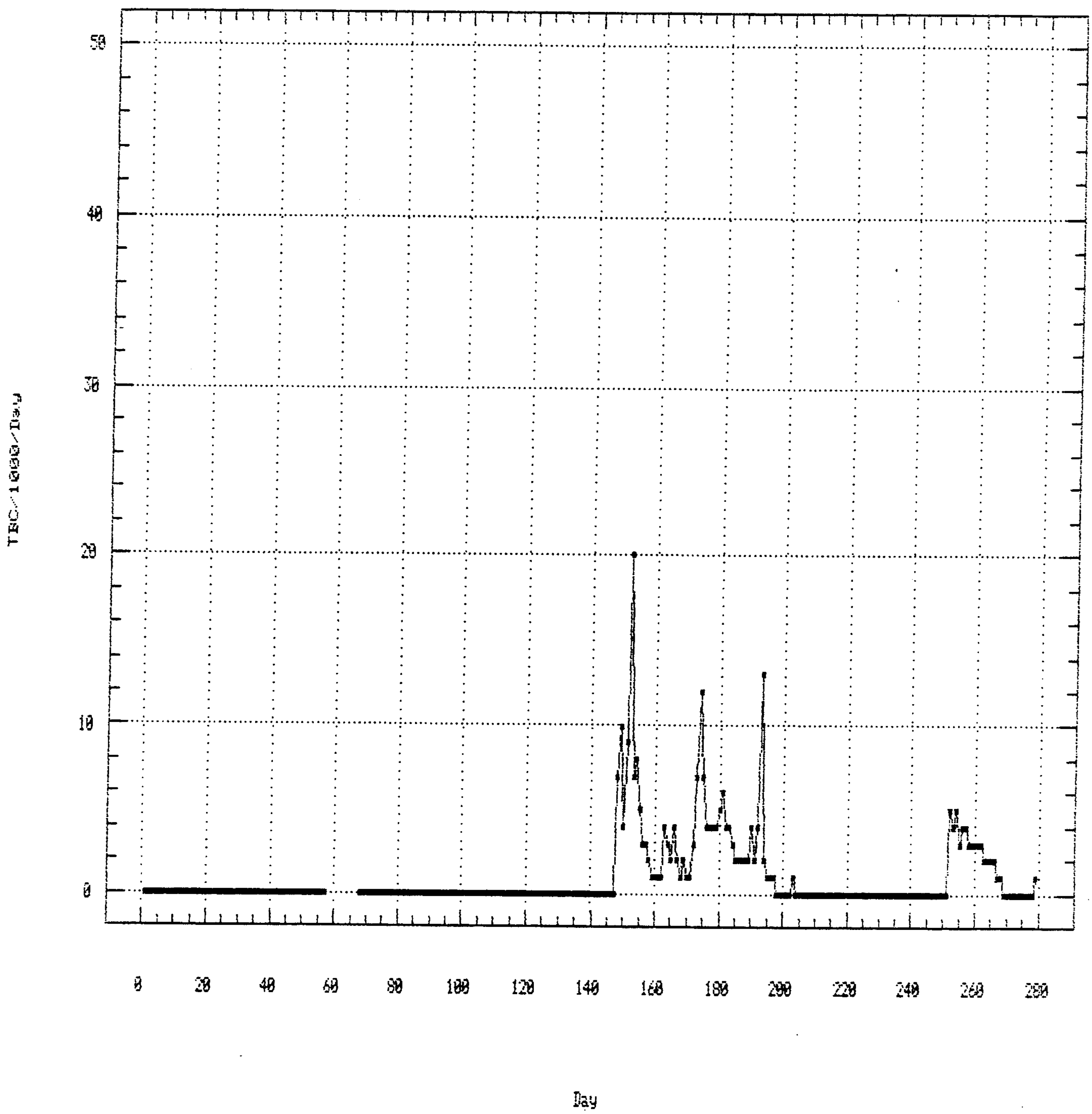
XVI Corps

(Division-level Casualty Rate)



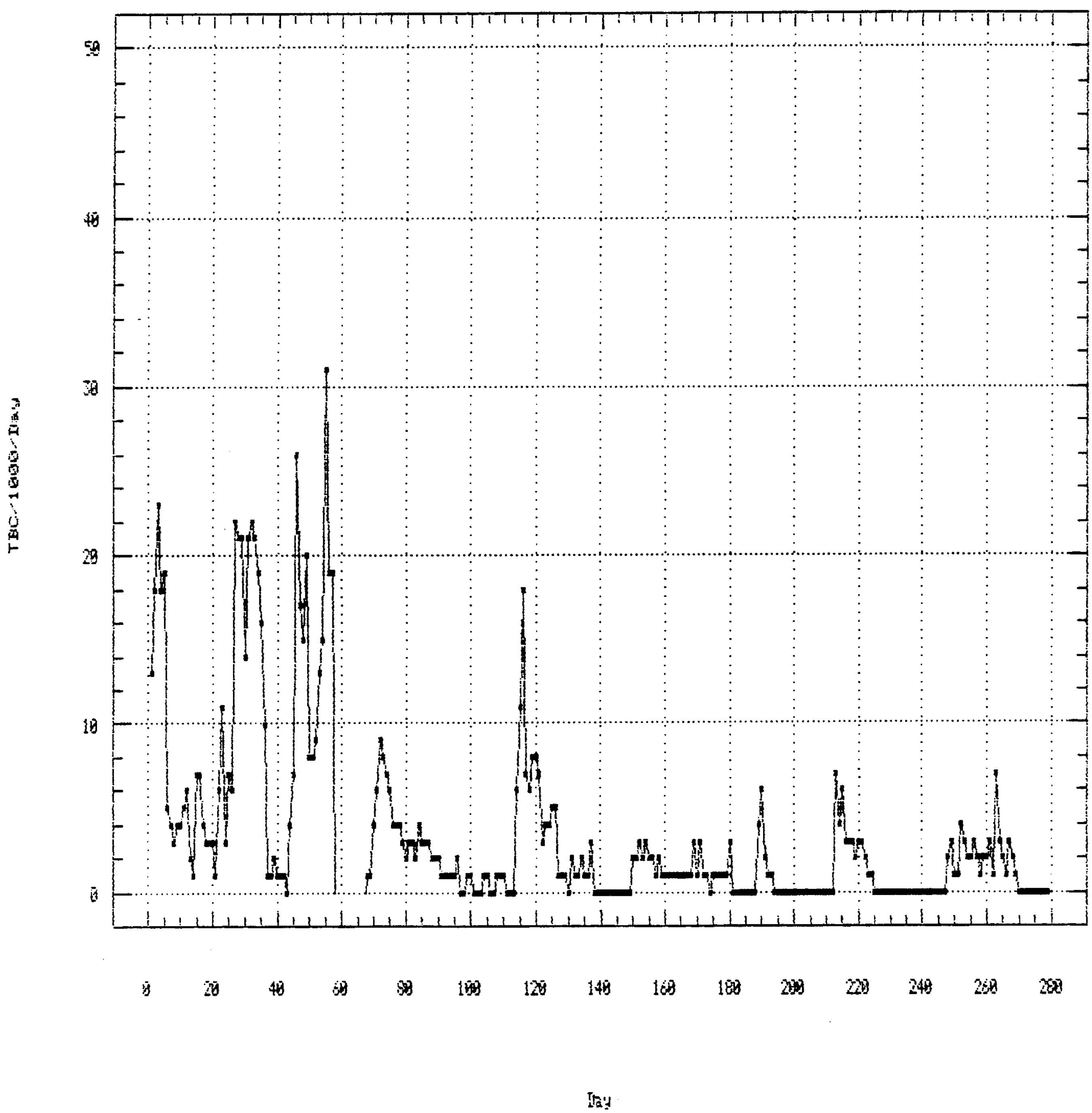
XVIII Airborne Corps

(Division-level Casualty Rate)



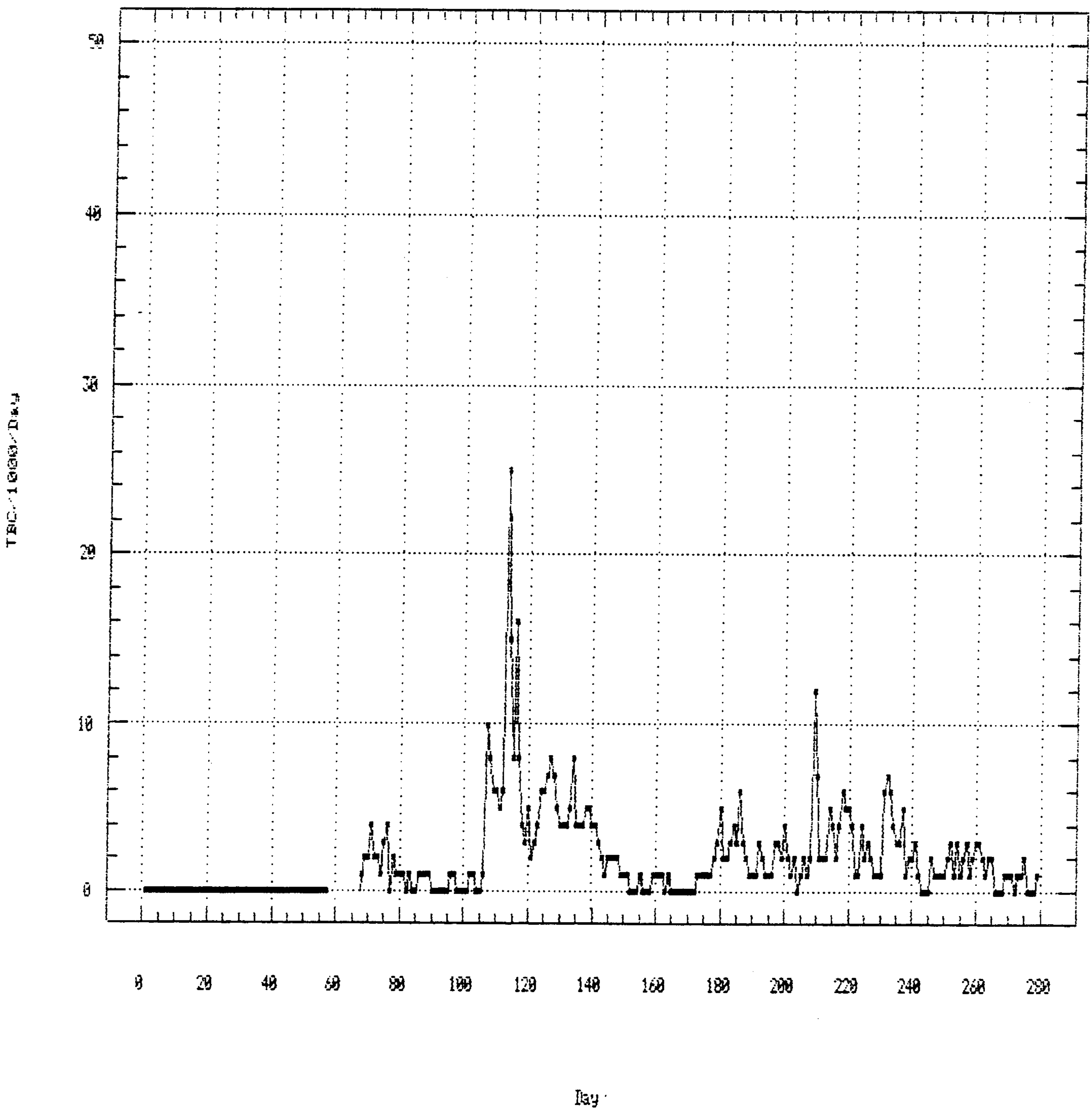
XIX Corps

(Division-level Casualty Rate)



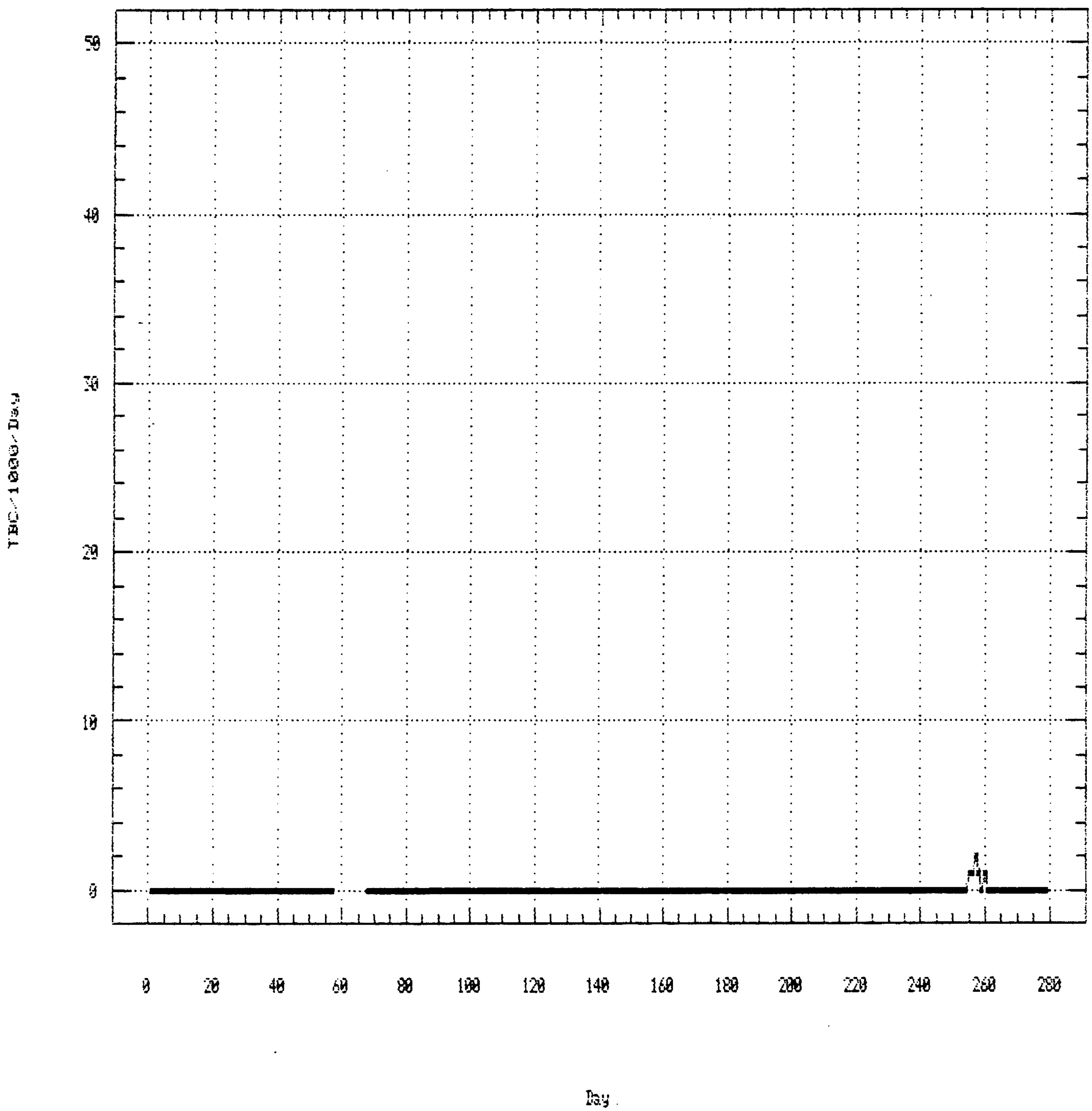
XX Corps

(Division-level Casualty Rate)



XXII Corps

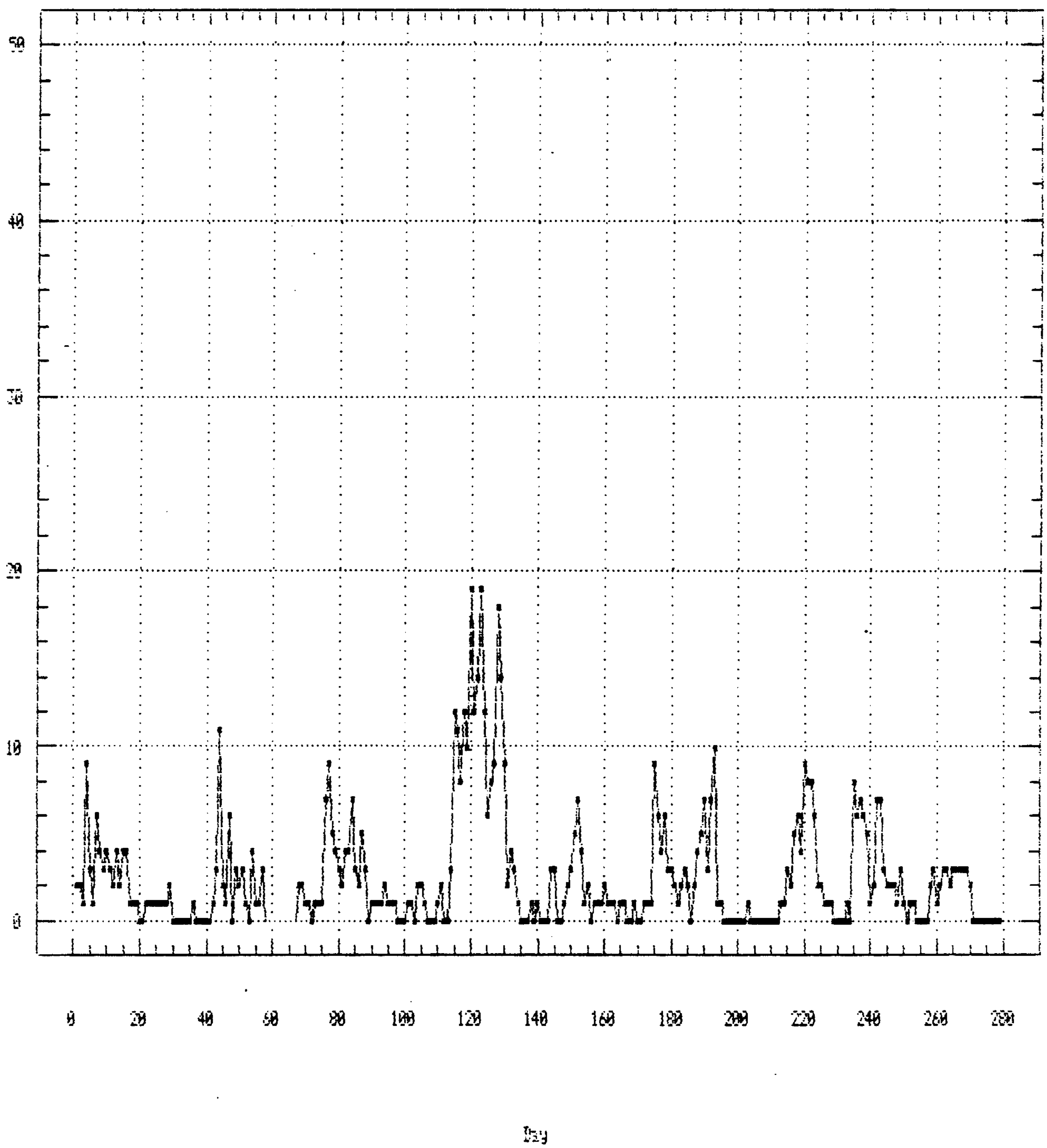
(Division-level Casualty Rate)



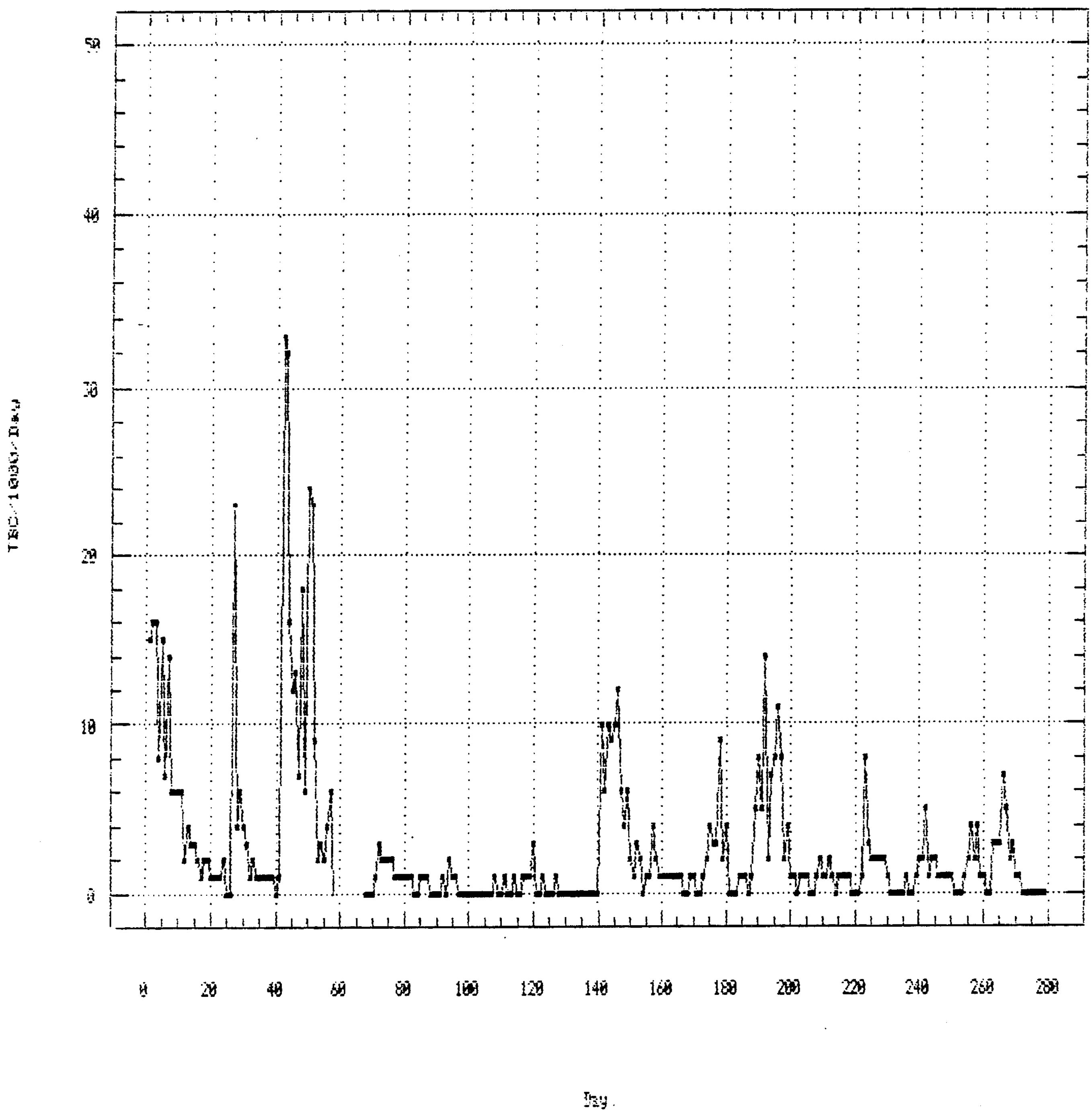
DIVISION GRAPHS

(pages B-25 to B-73)

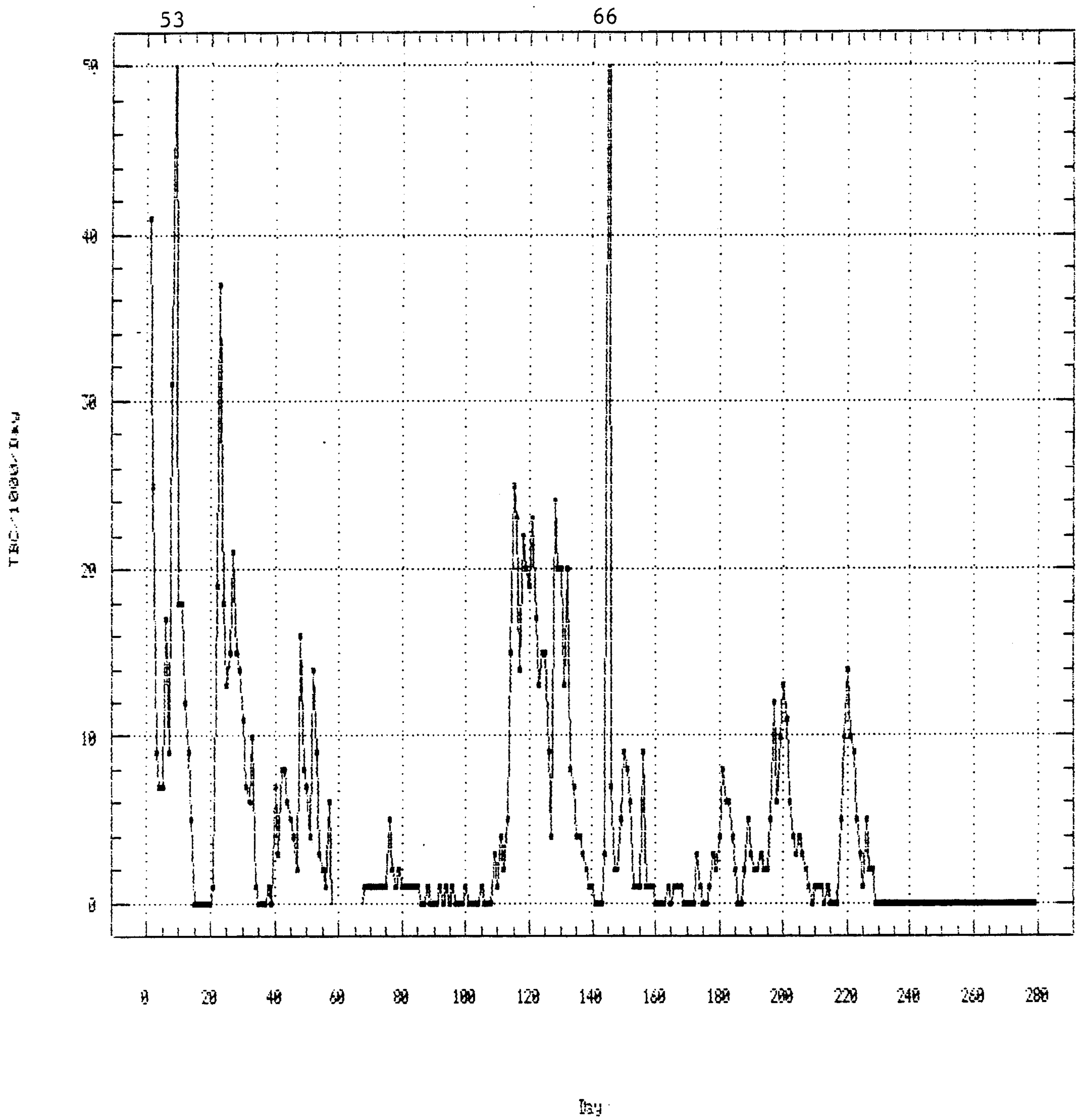
1st Infantry Division



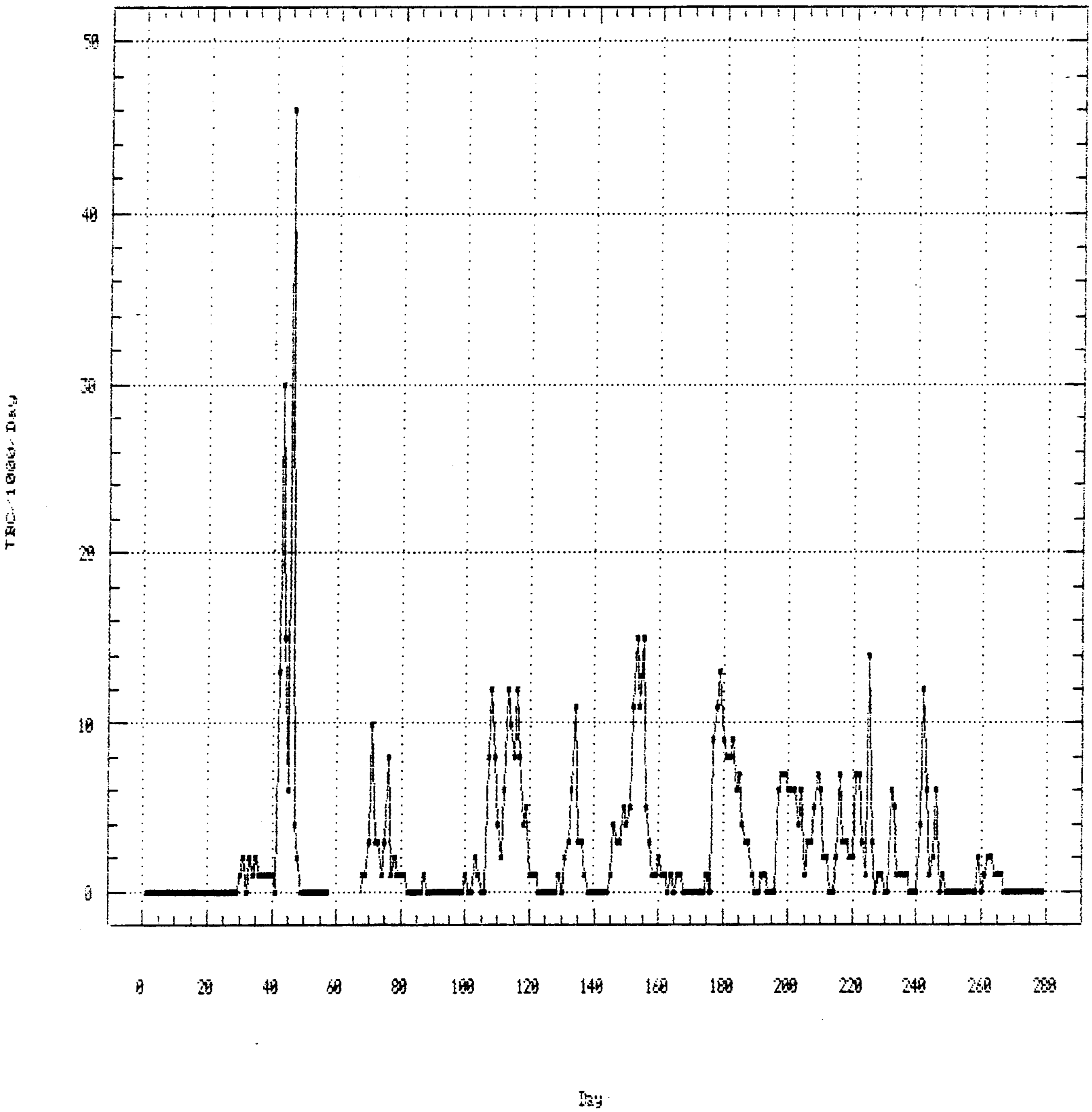
2d Infantry Division



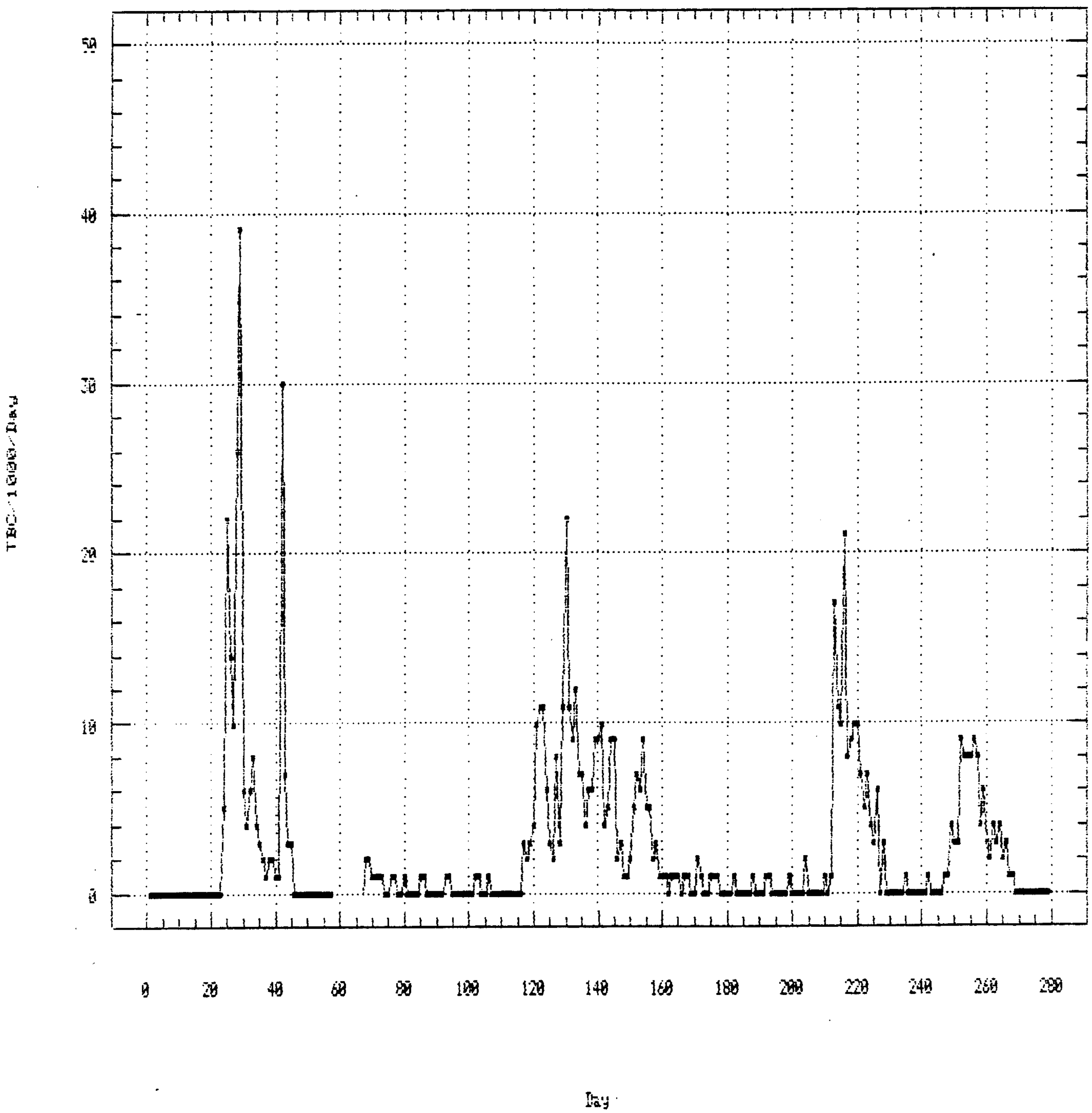
4th Infantry Division



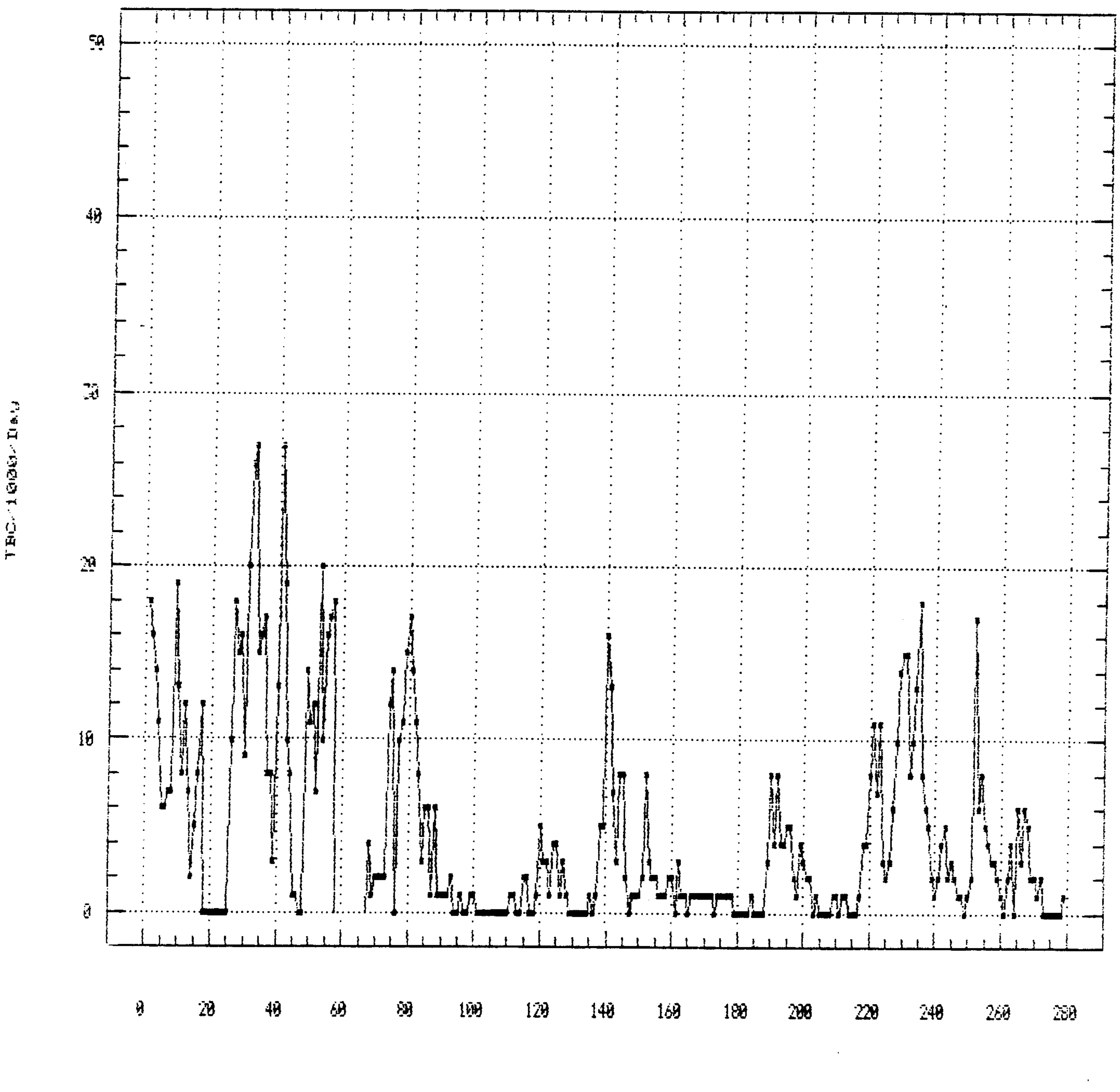
5th Infantry Division



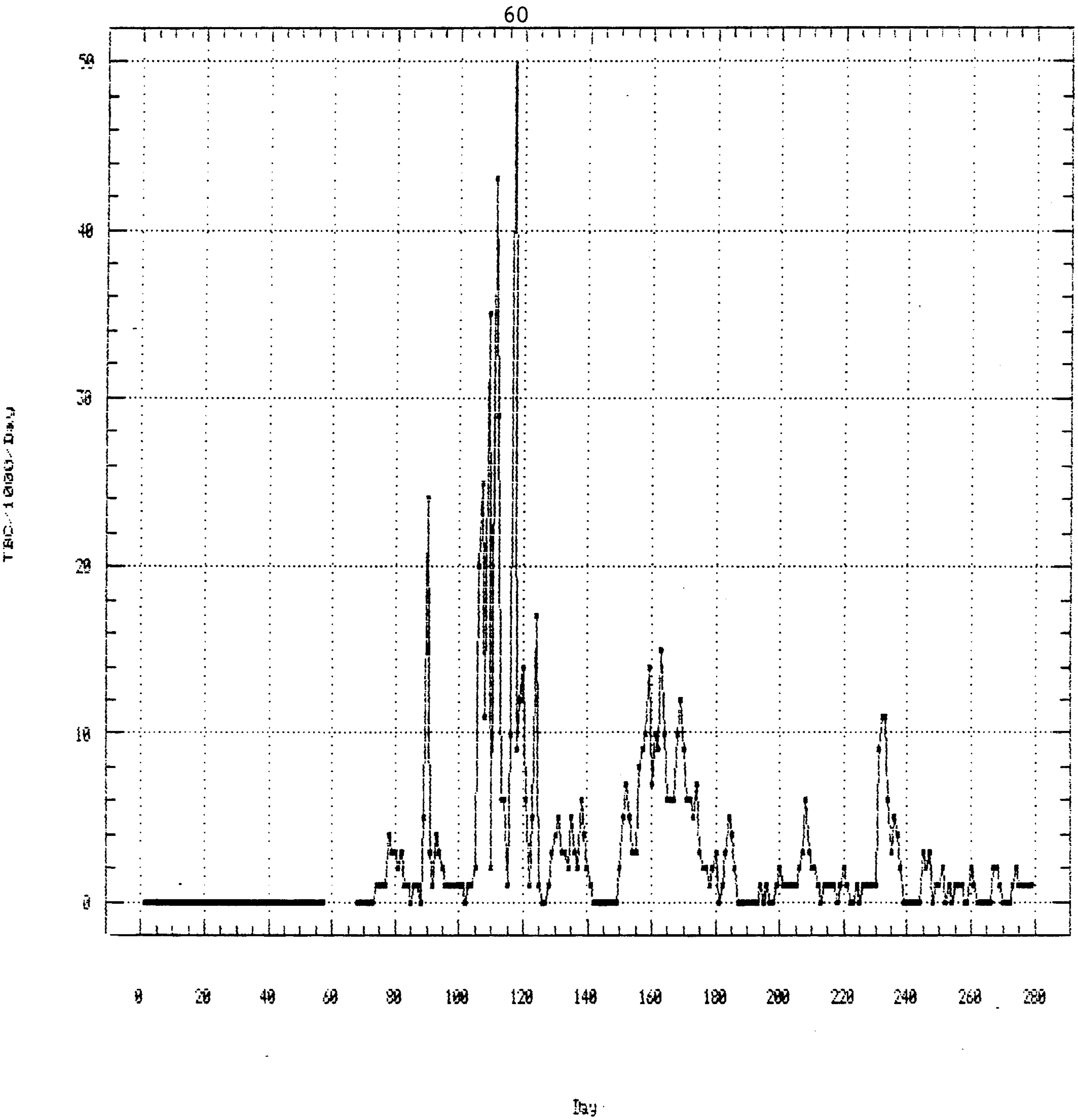
8th Infantry Division



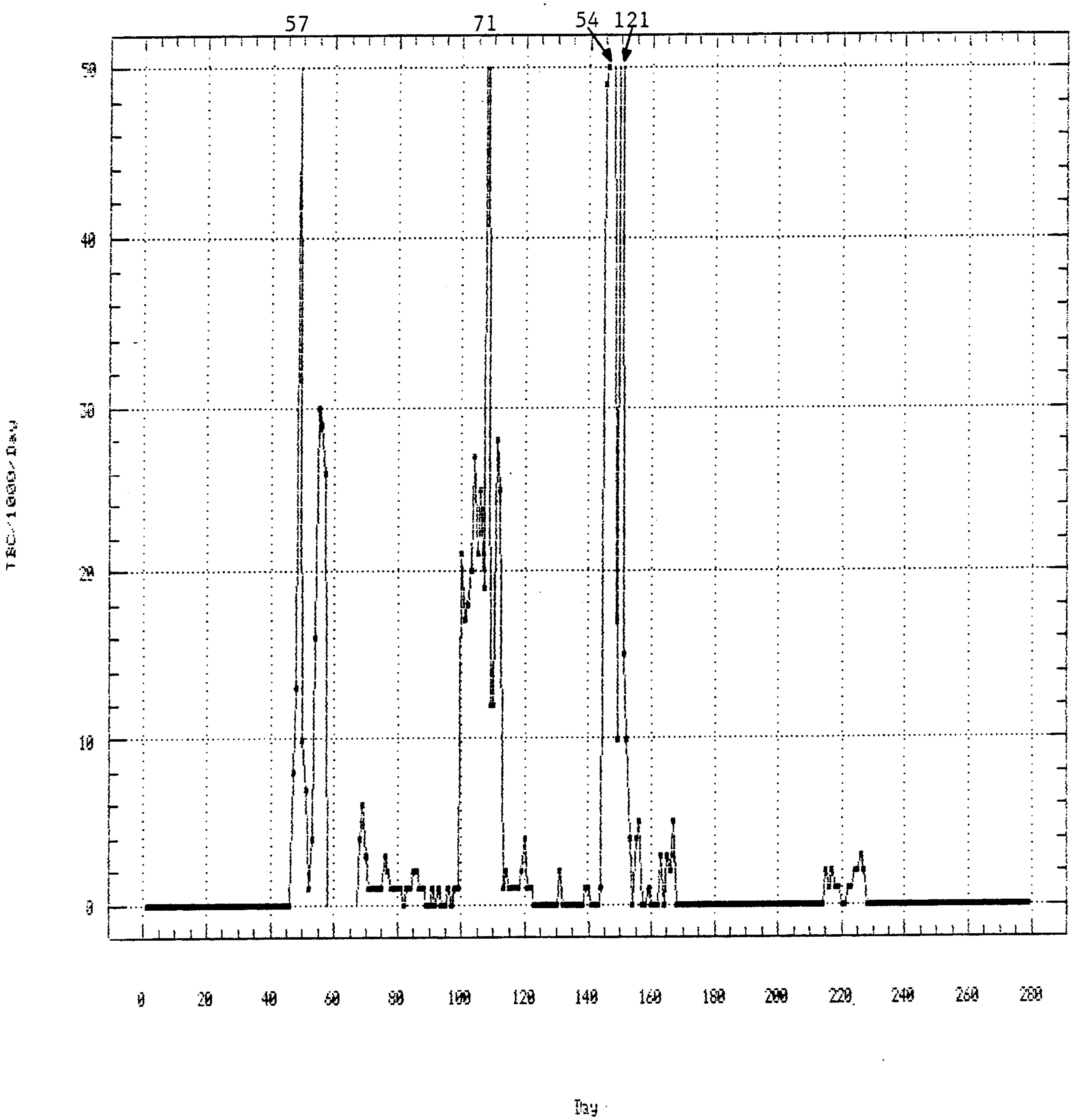
9th Infantry Division



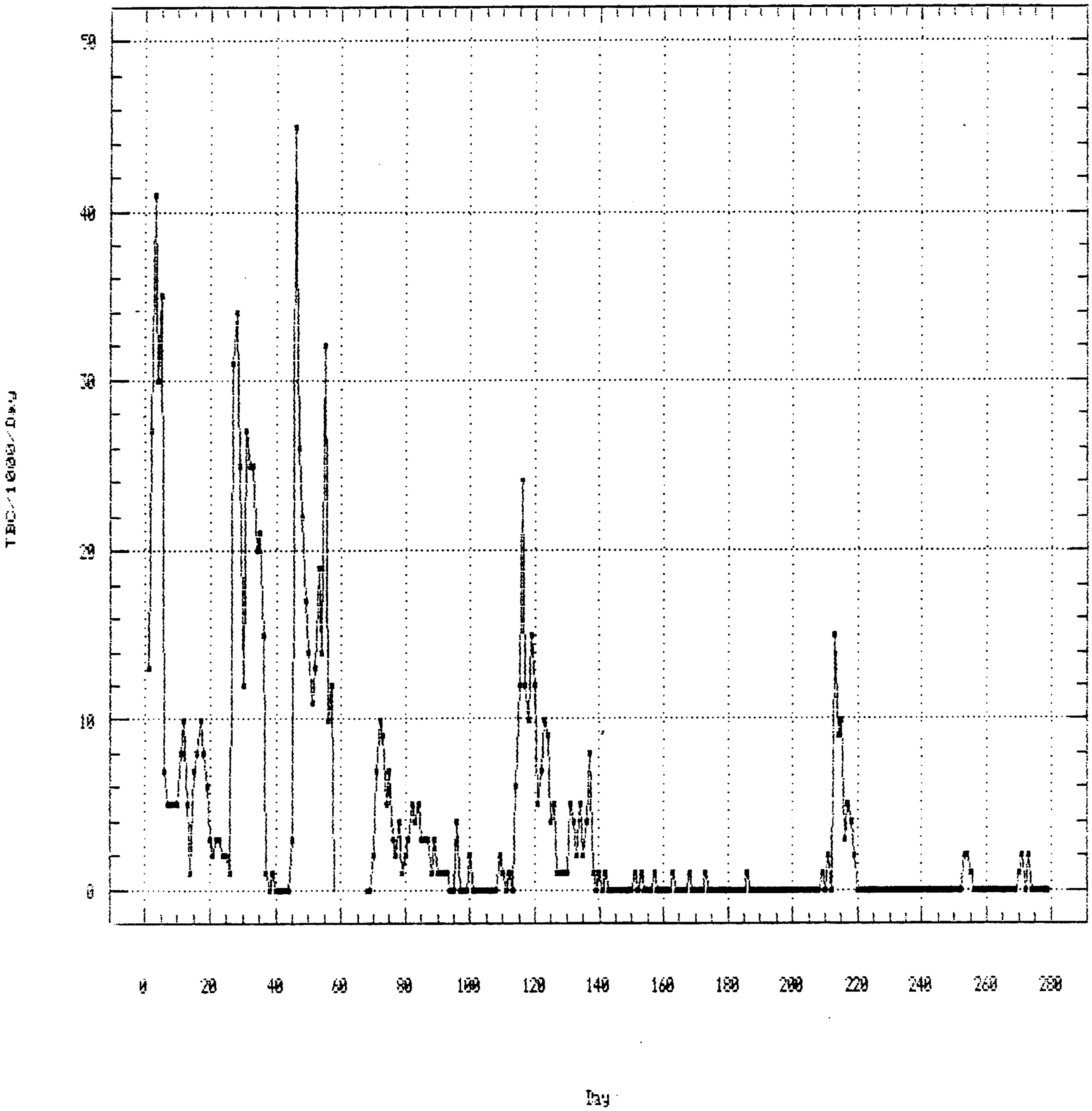
26th Infantry Division



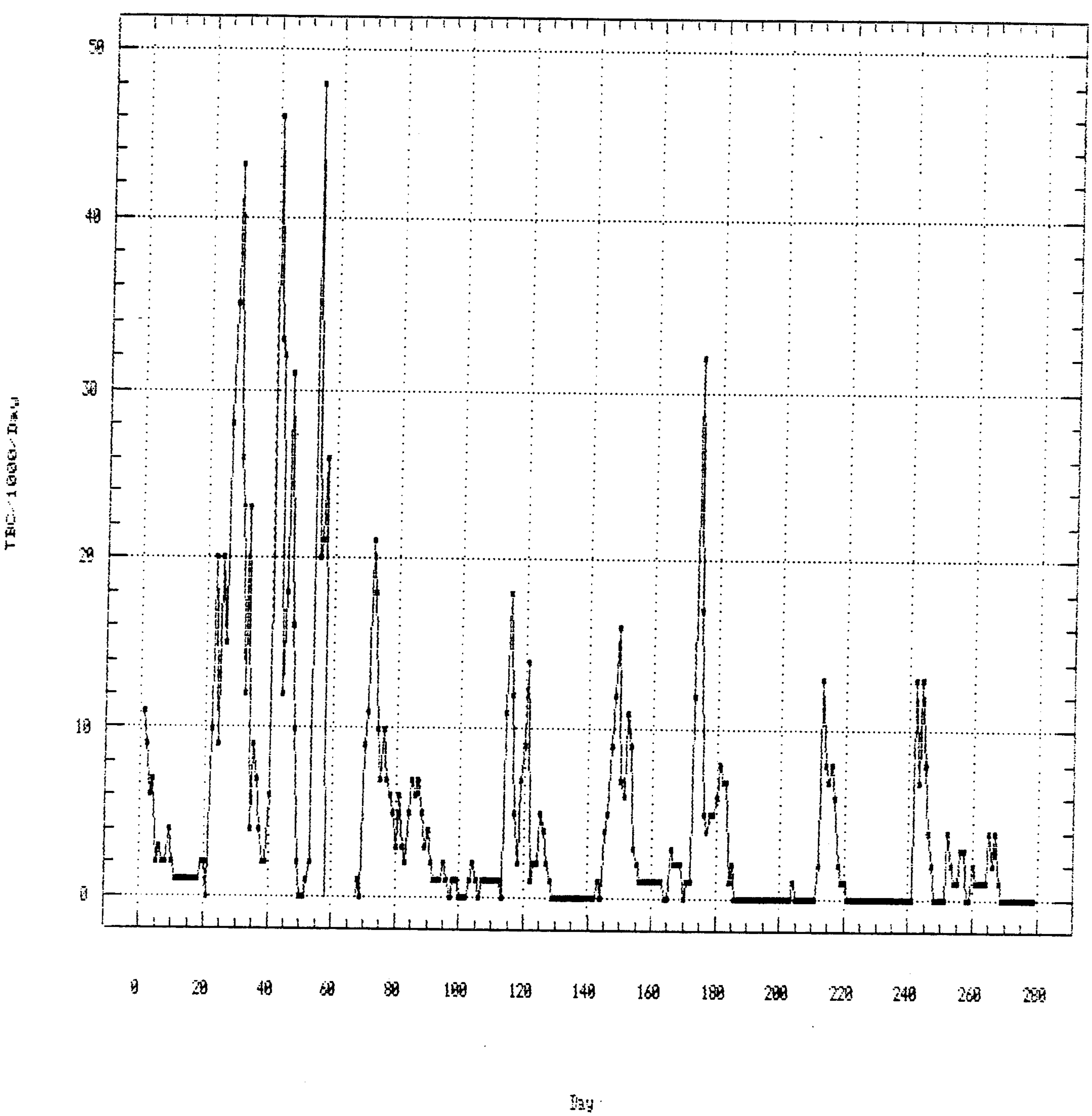
28th Infantry Division



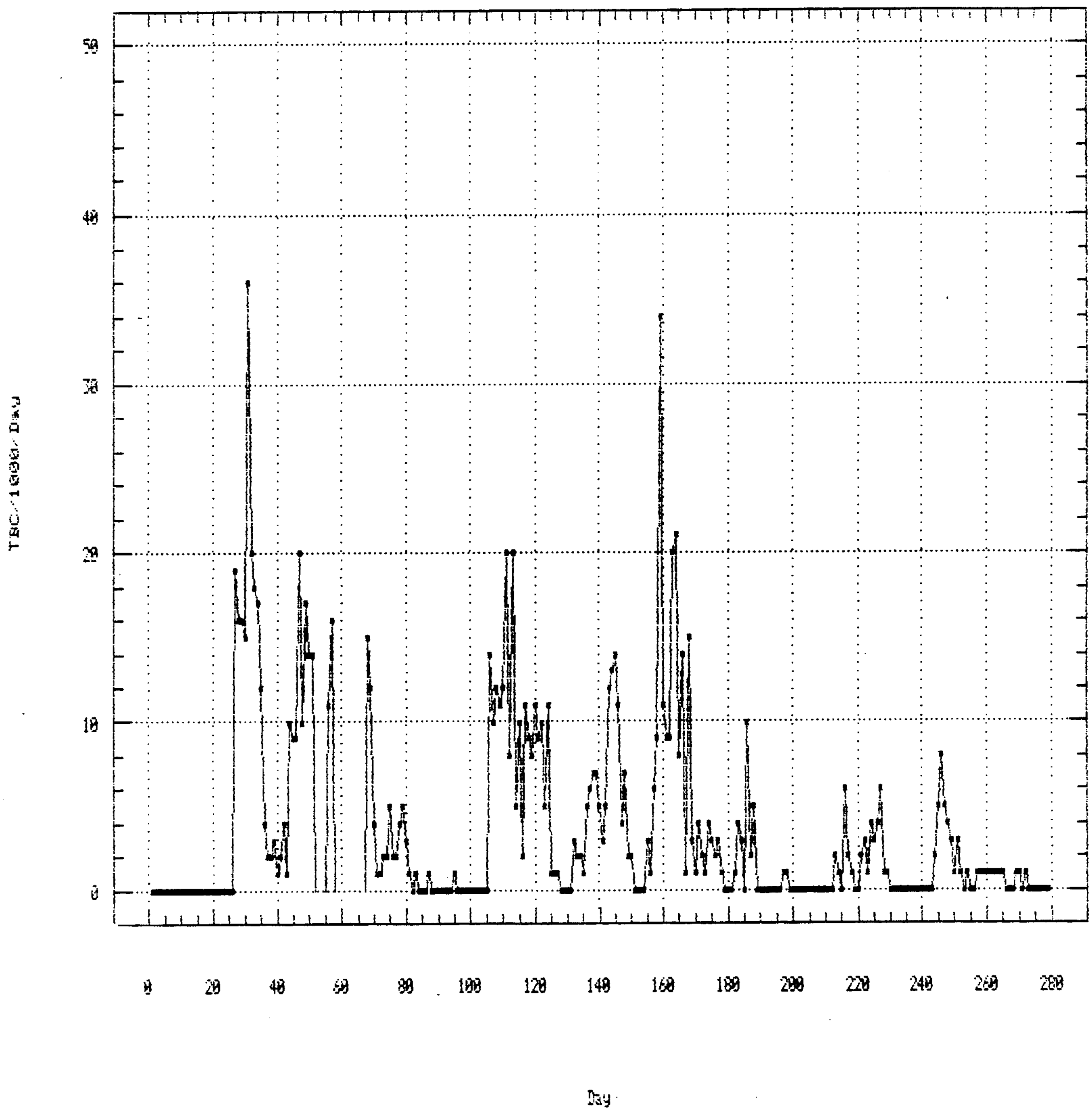
29th Infantry Division



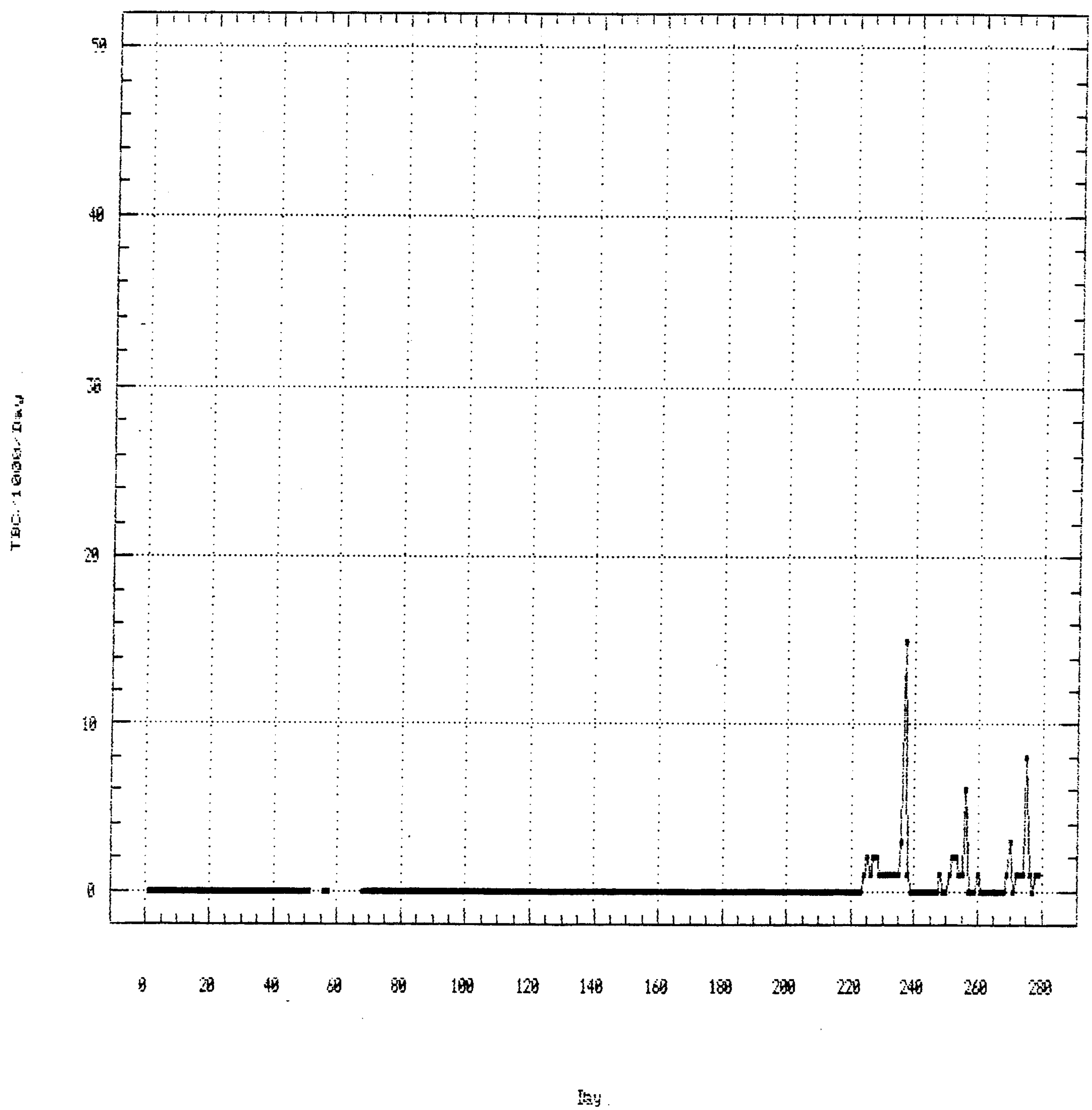
30th Infantry Division



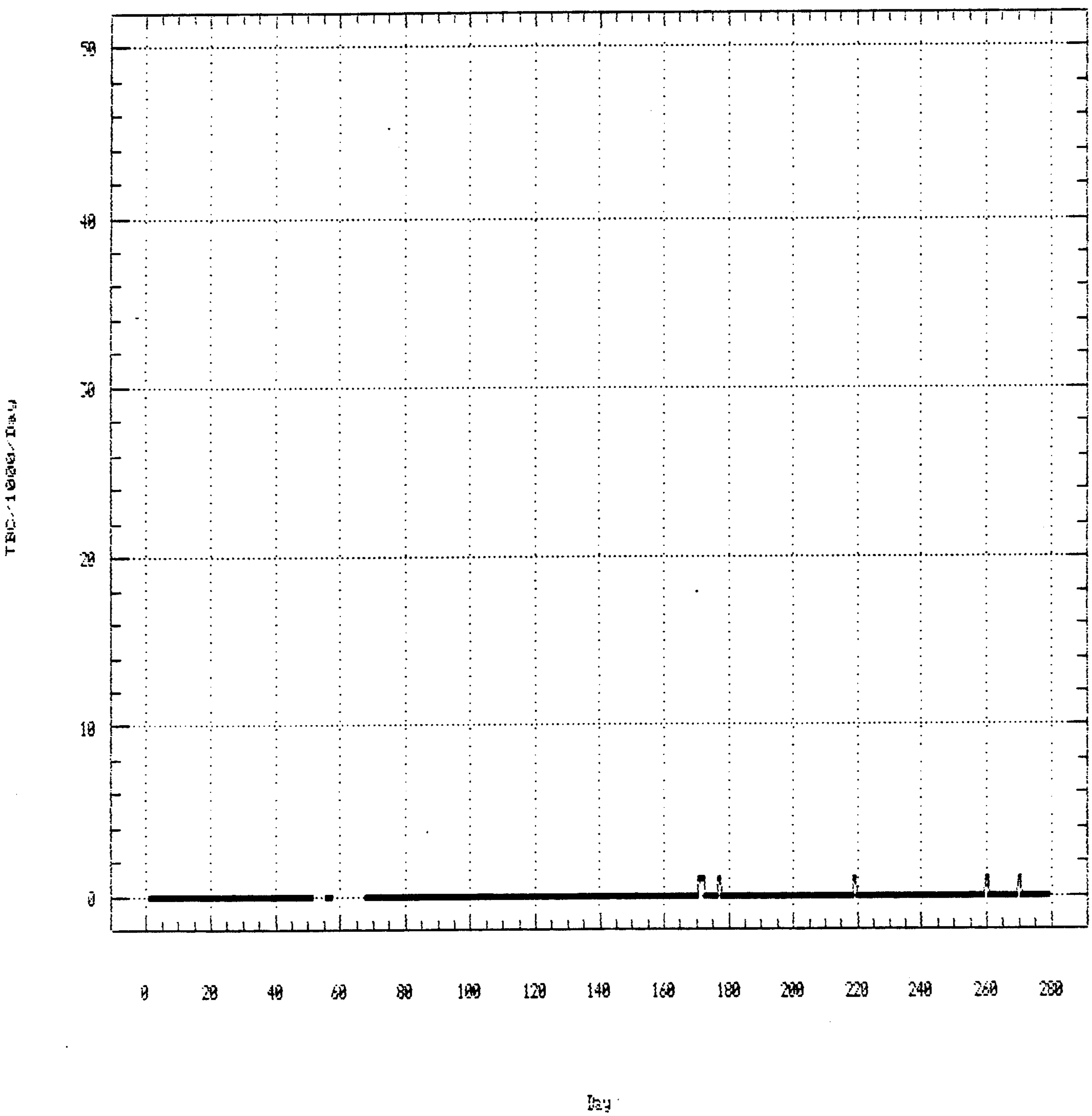
35th Infantry Division



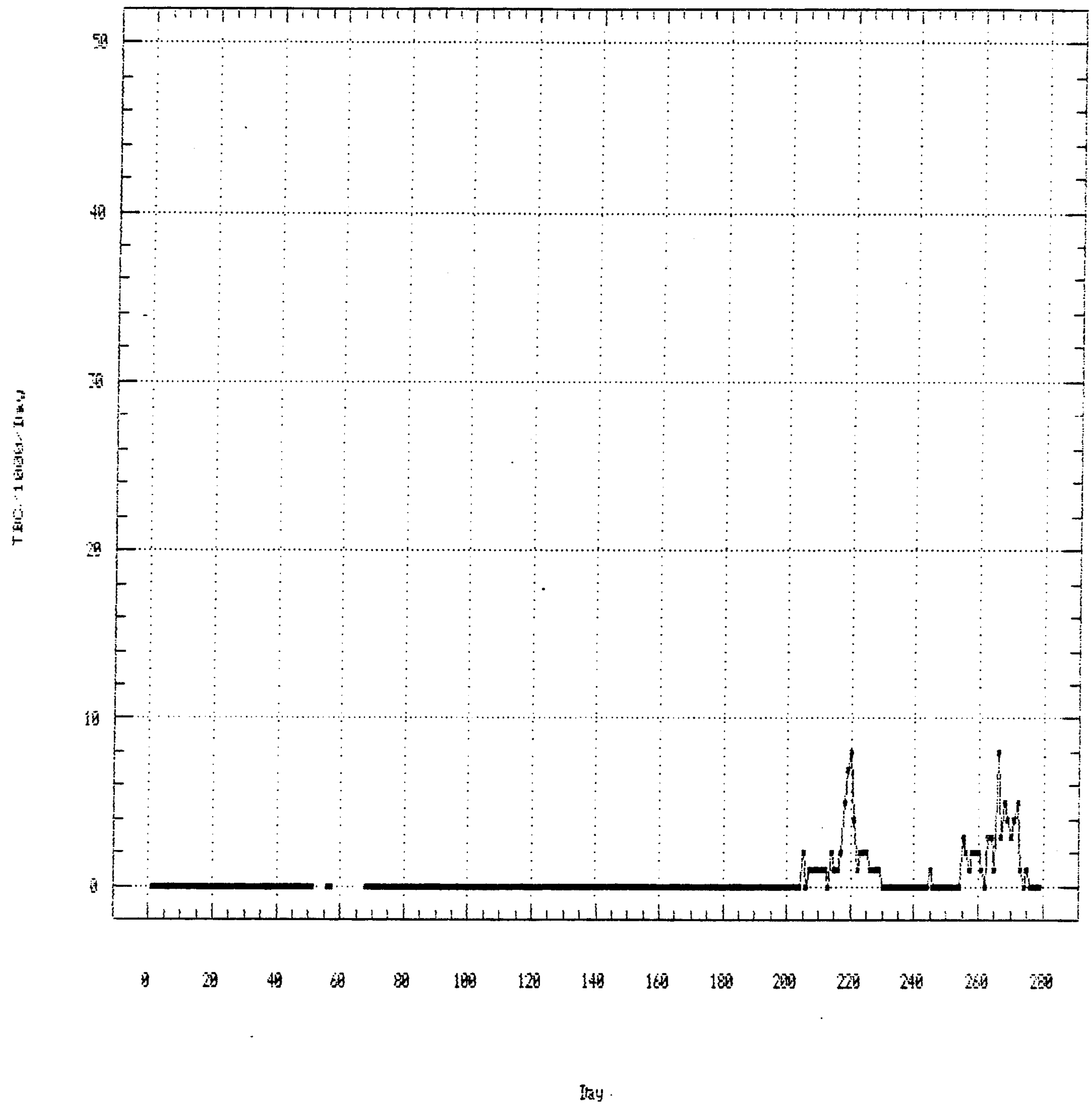
65th Infantry Division



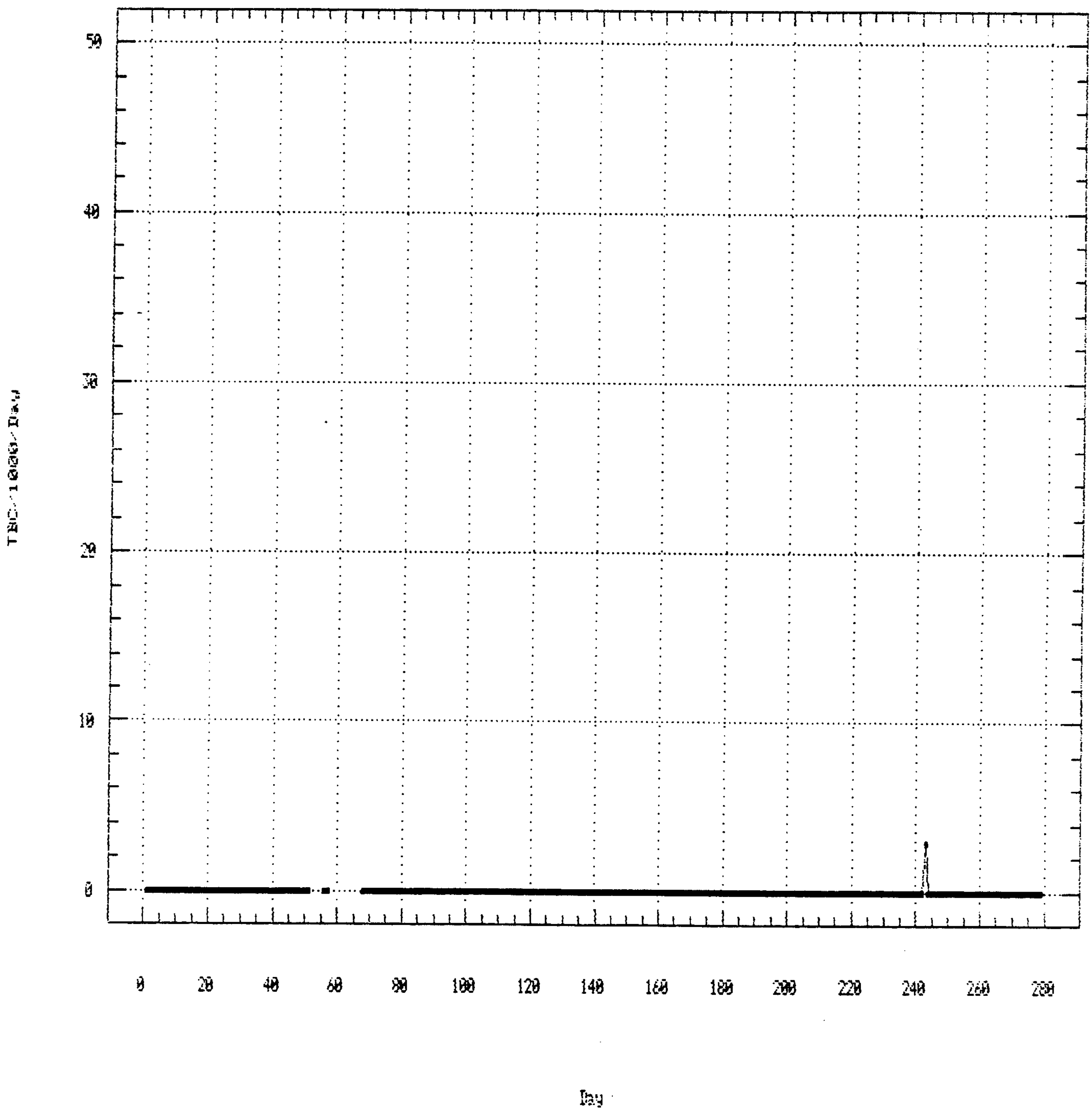
66th Infantry Division



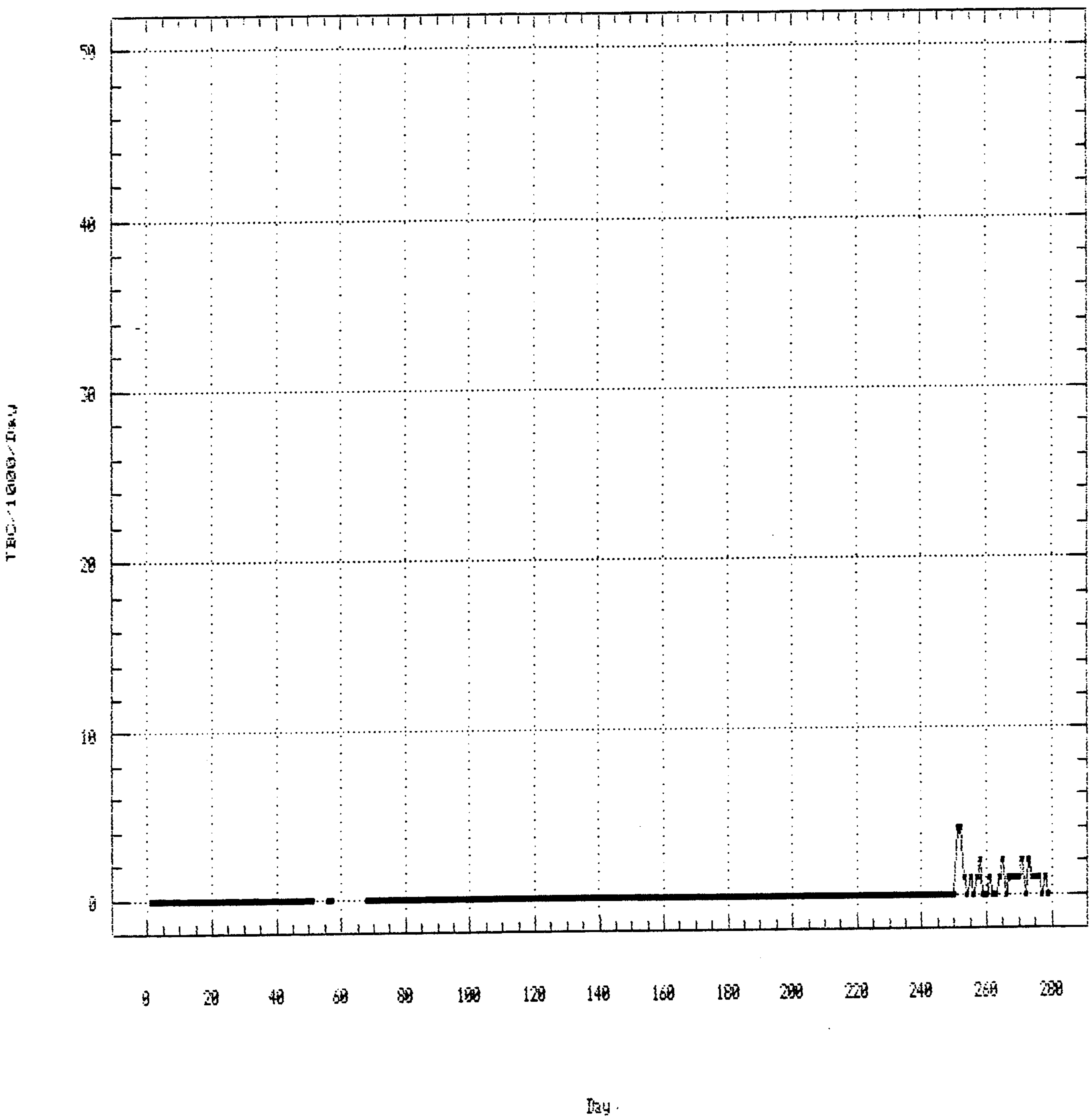
69th Infantry Division



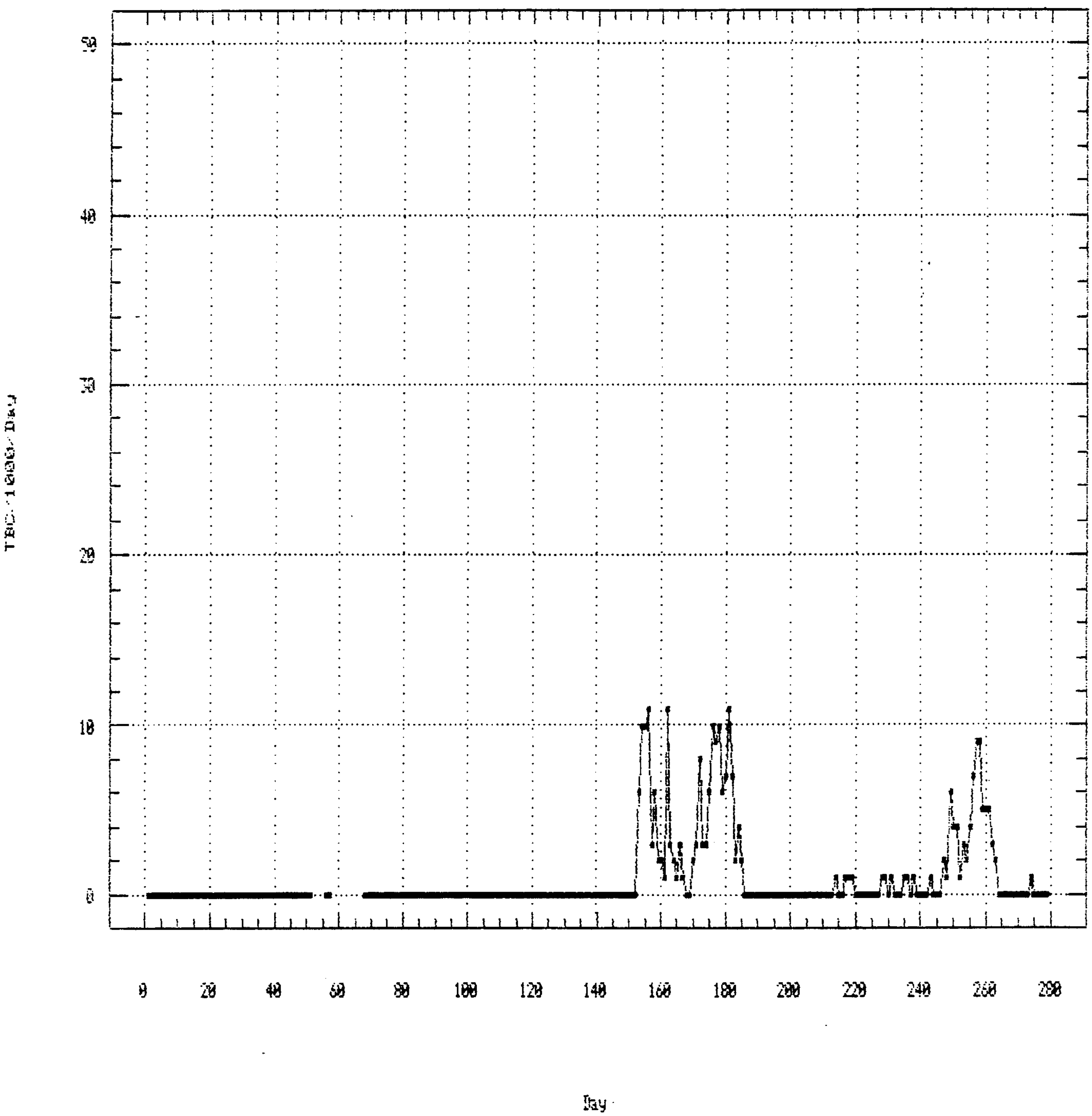
70th Infantry Division



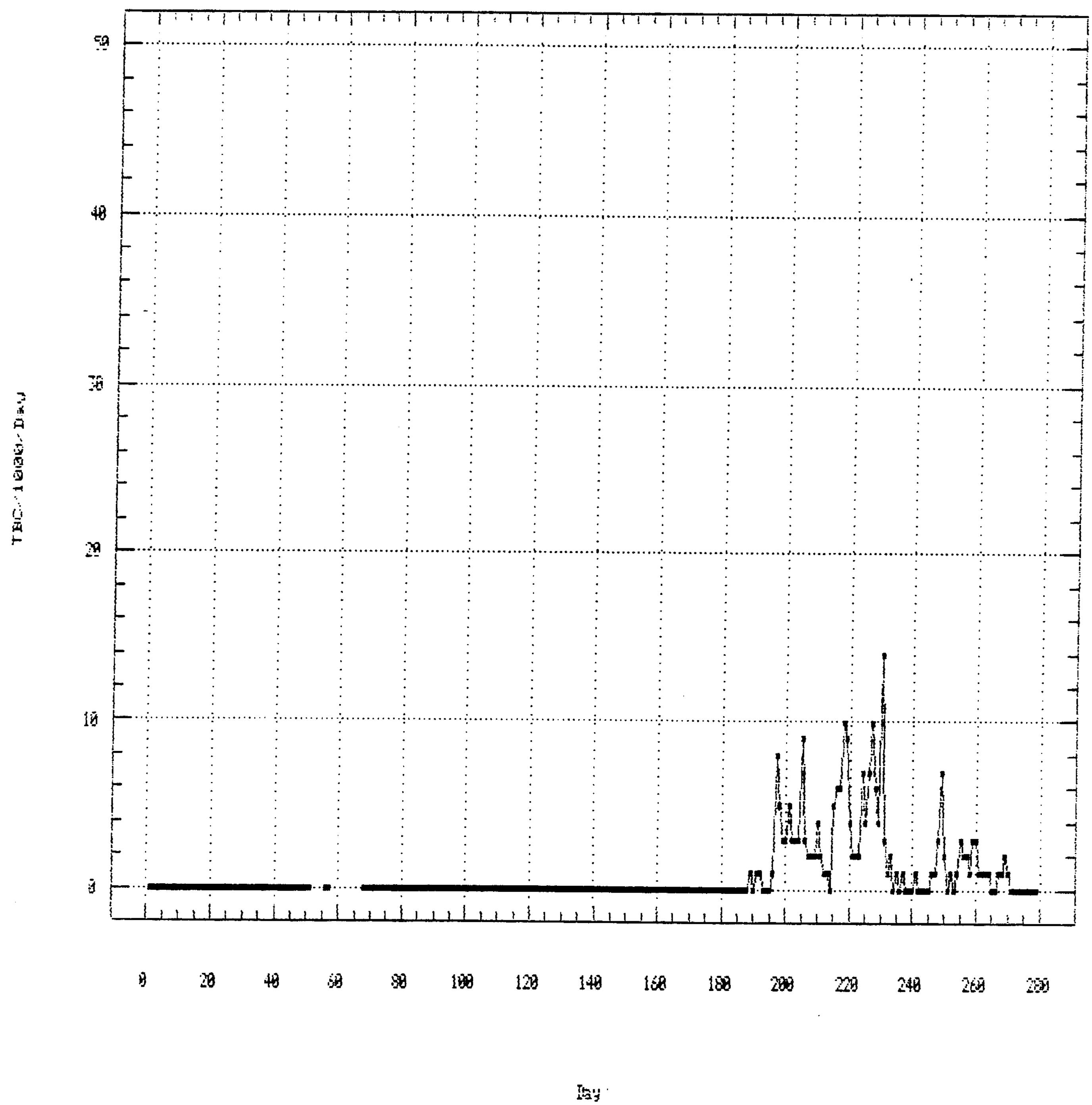
71st Infantry Division



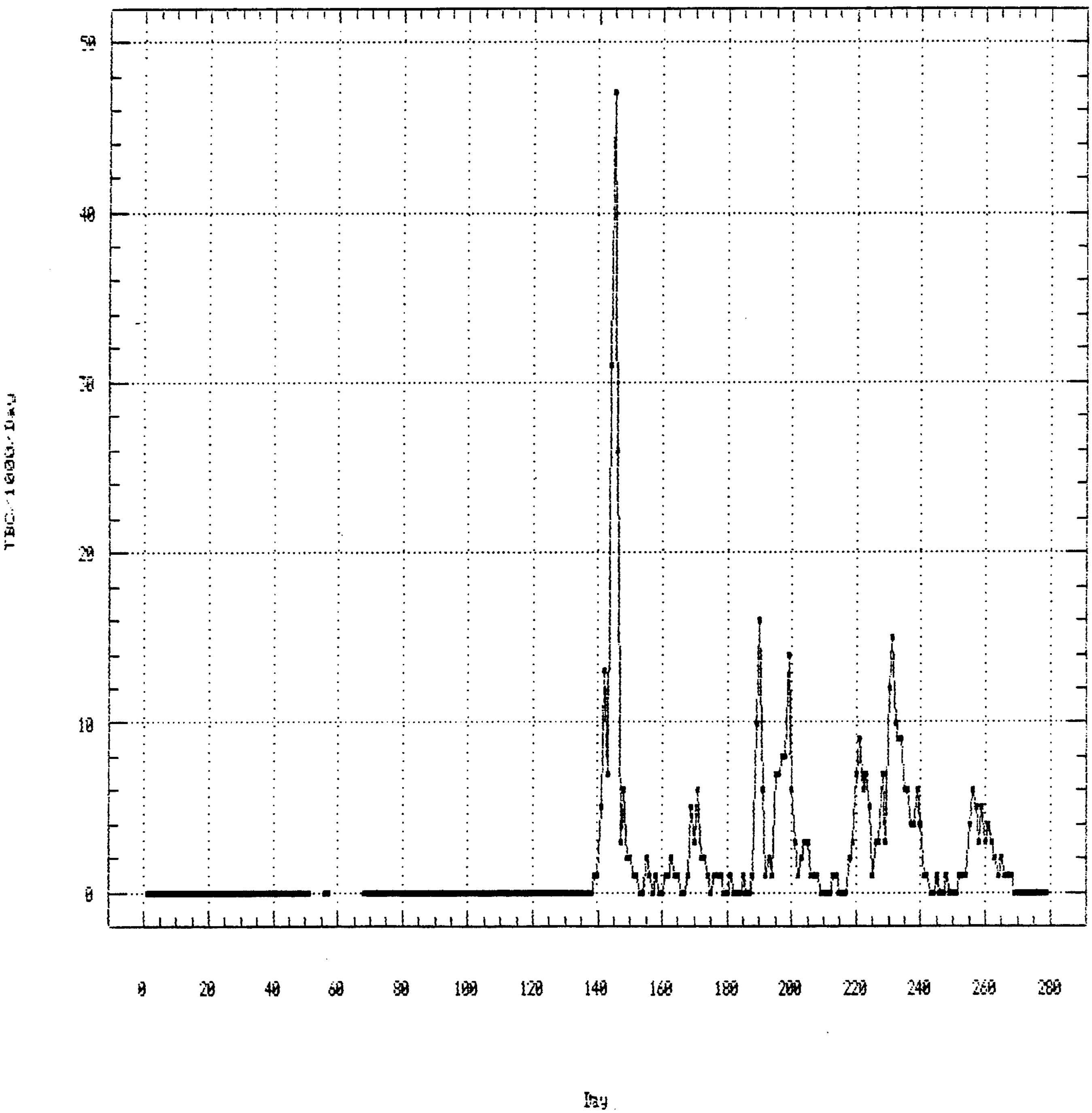
75th Infantry Division



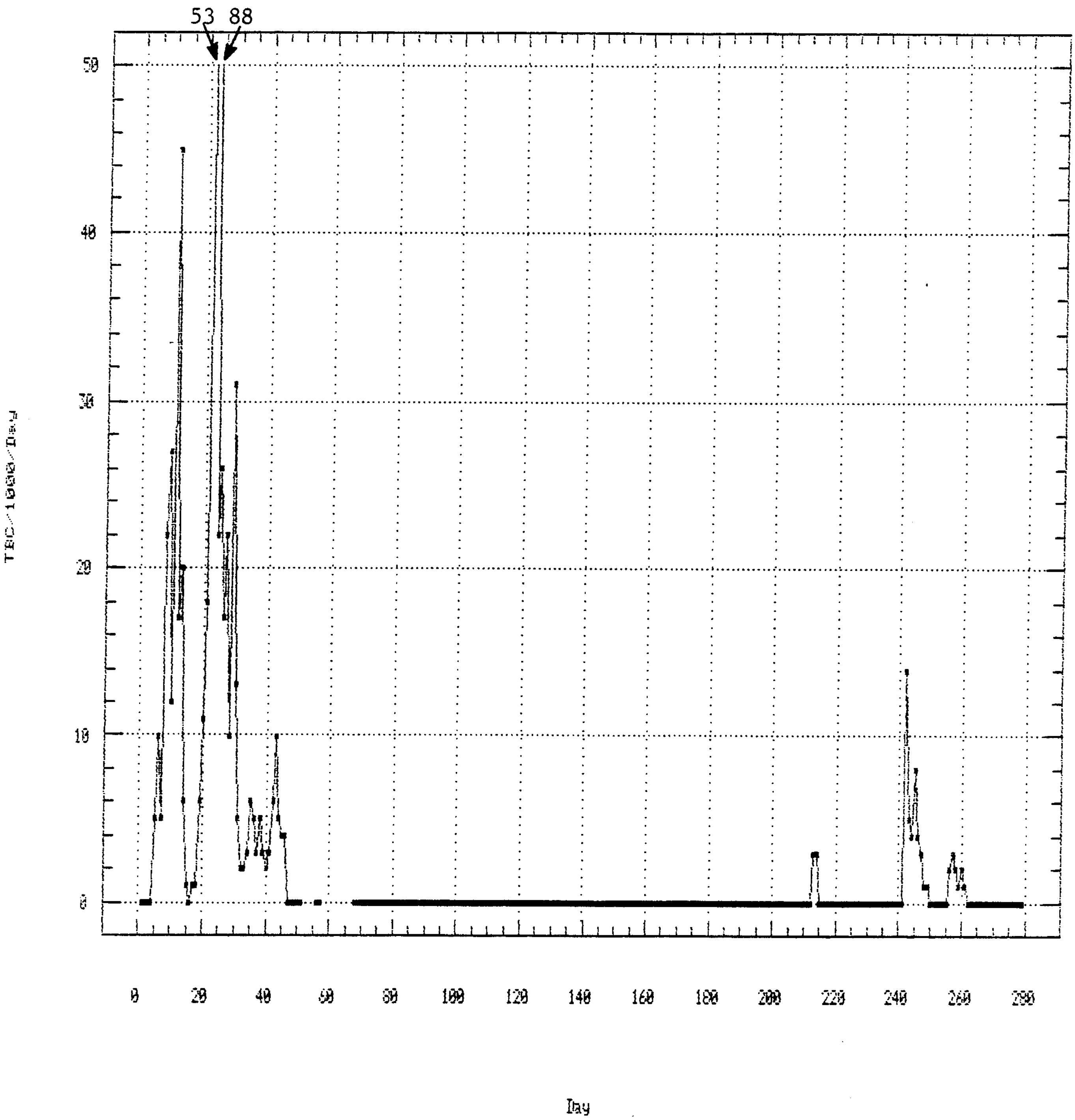
76th Infantry Division



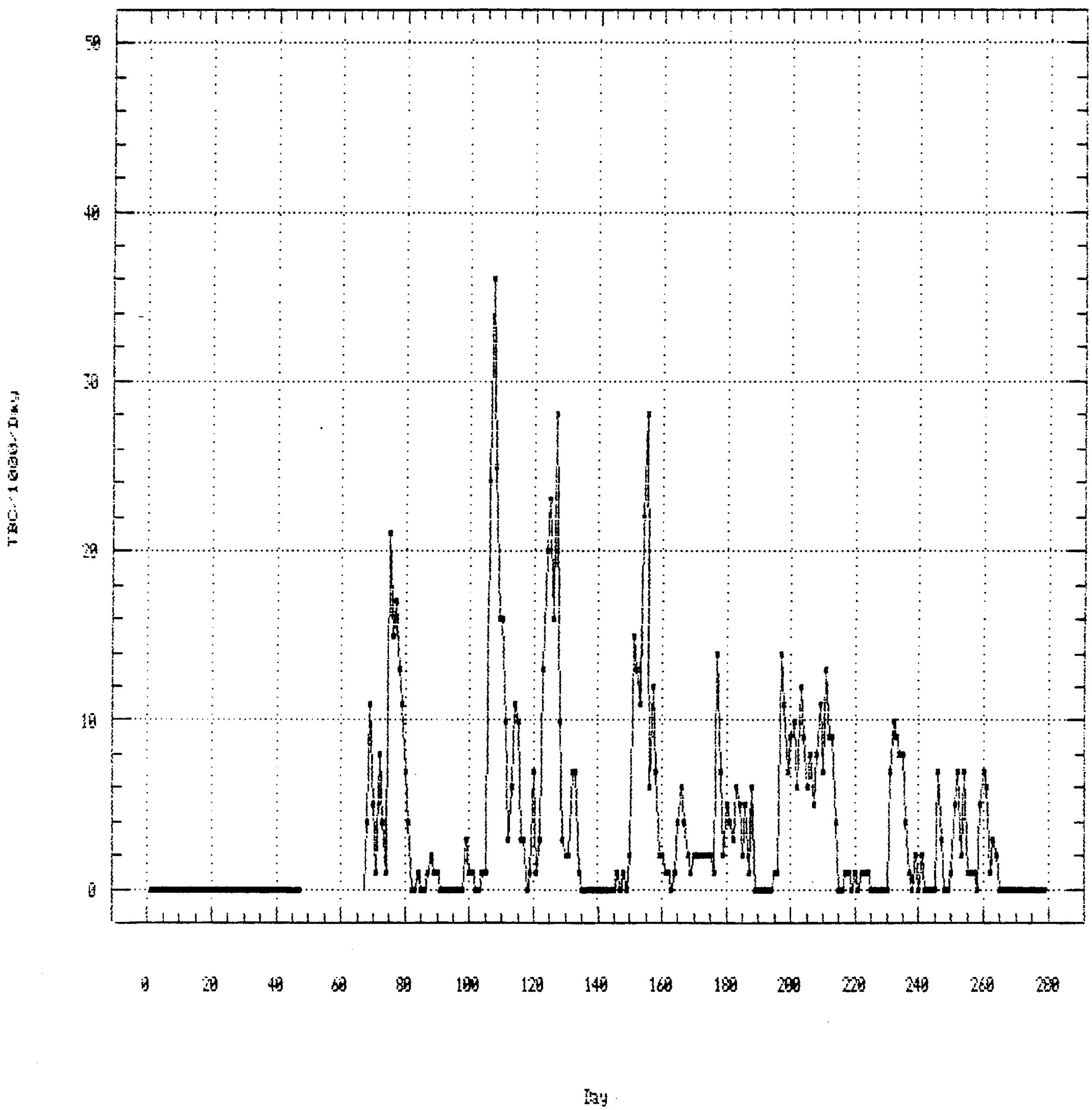
78th Infantry Division



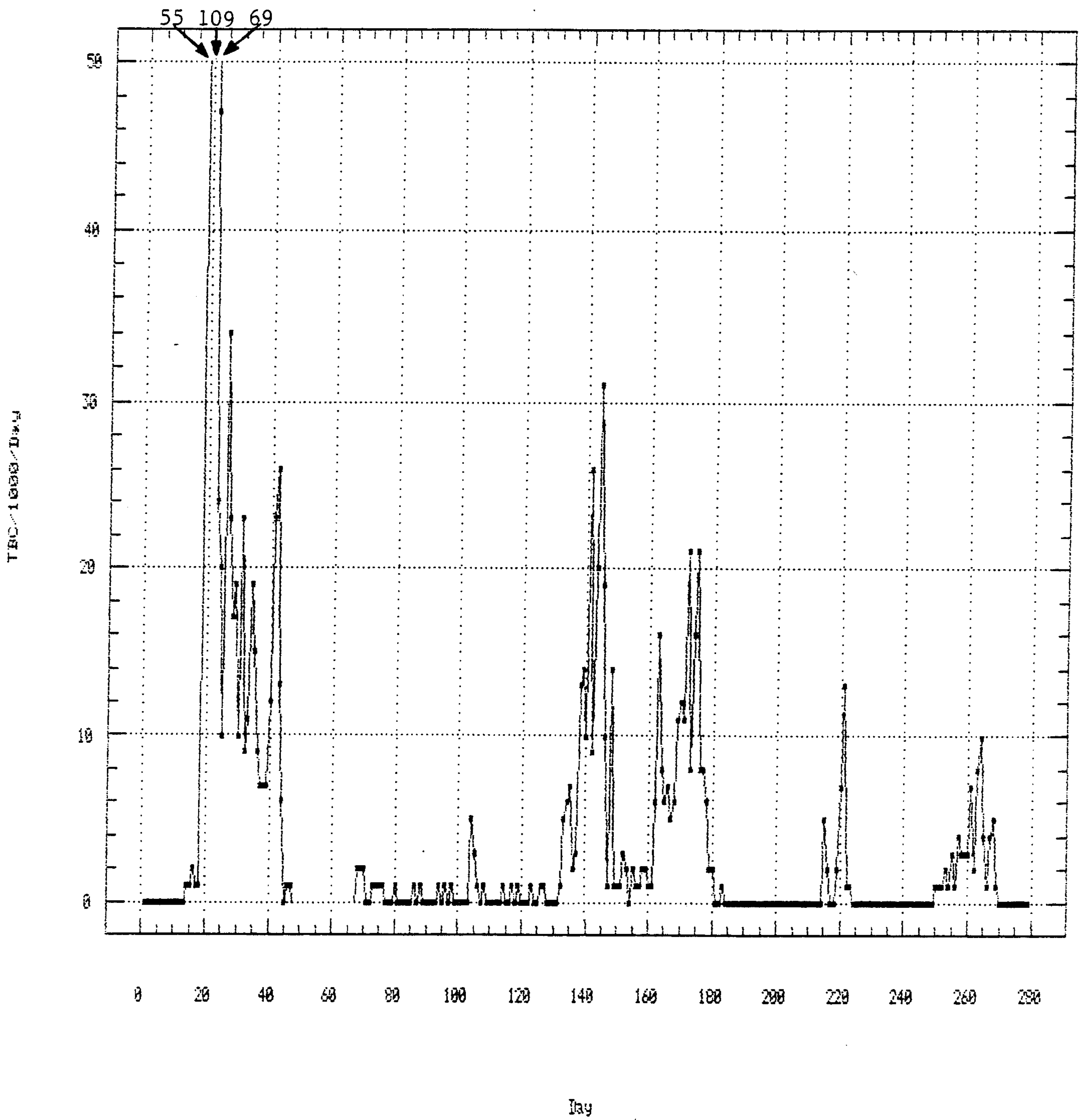
77th Infantry Division

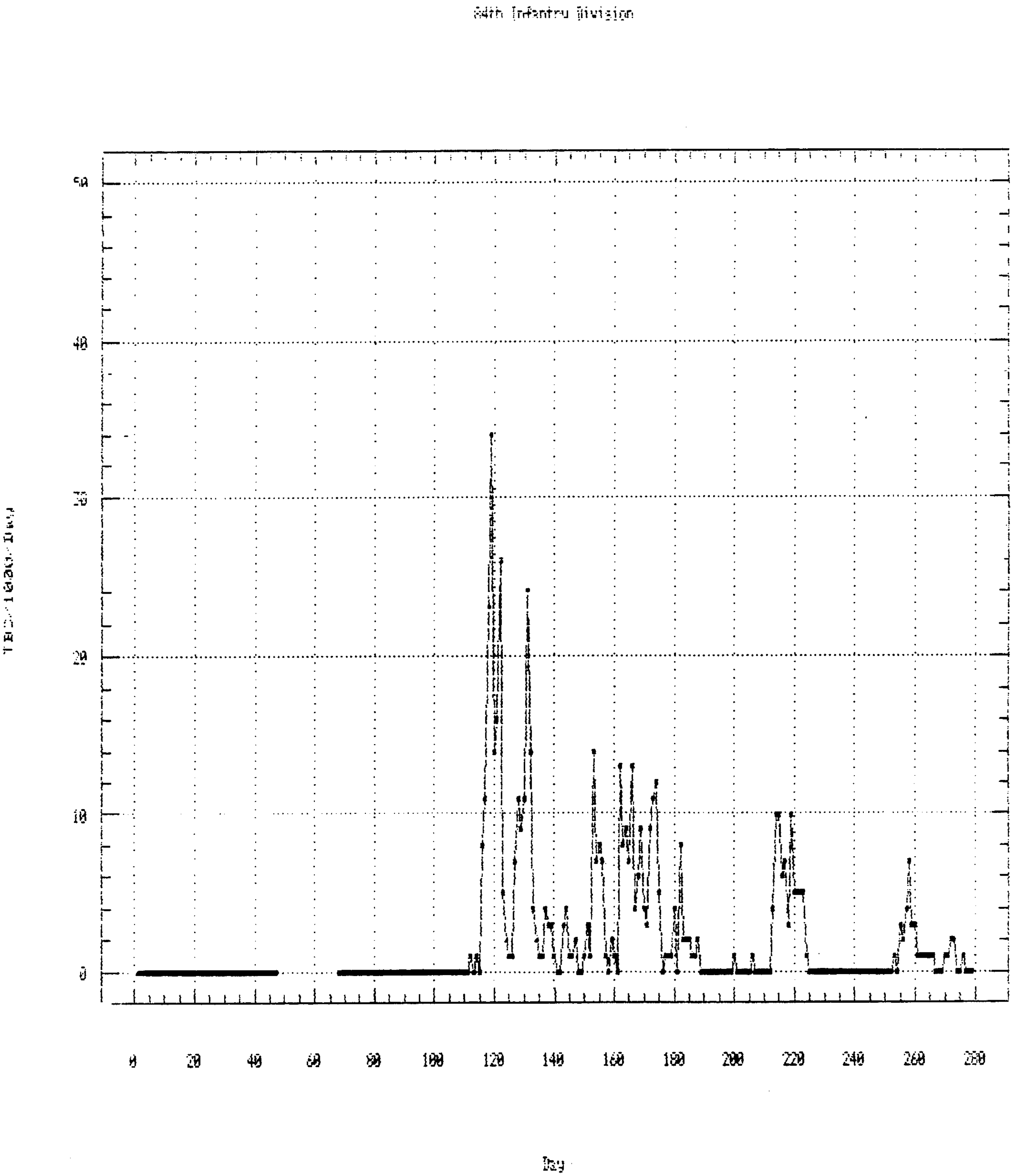


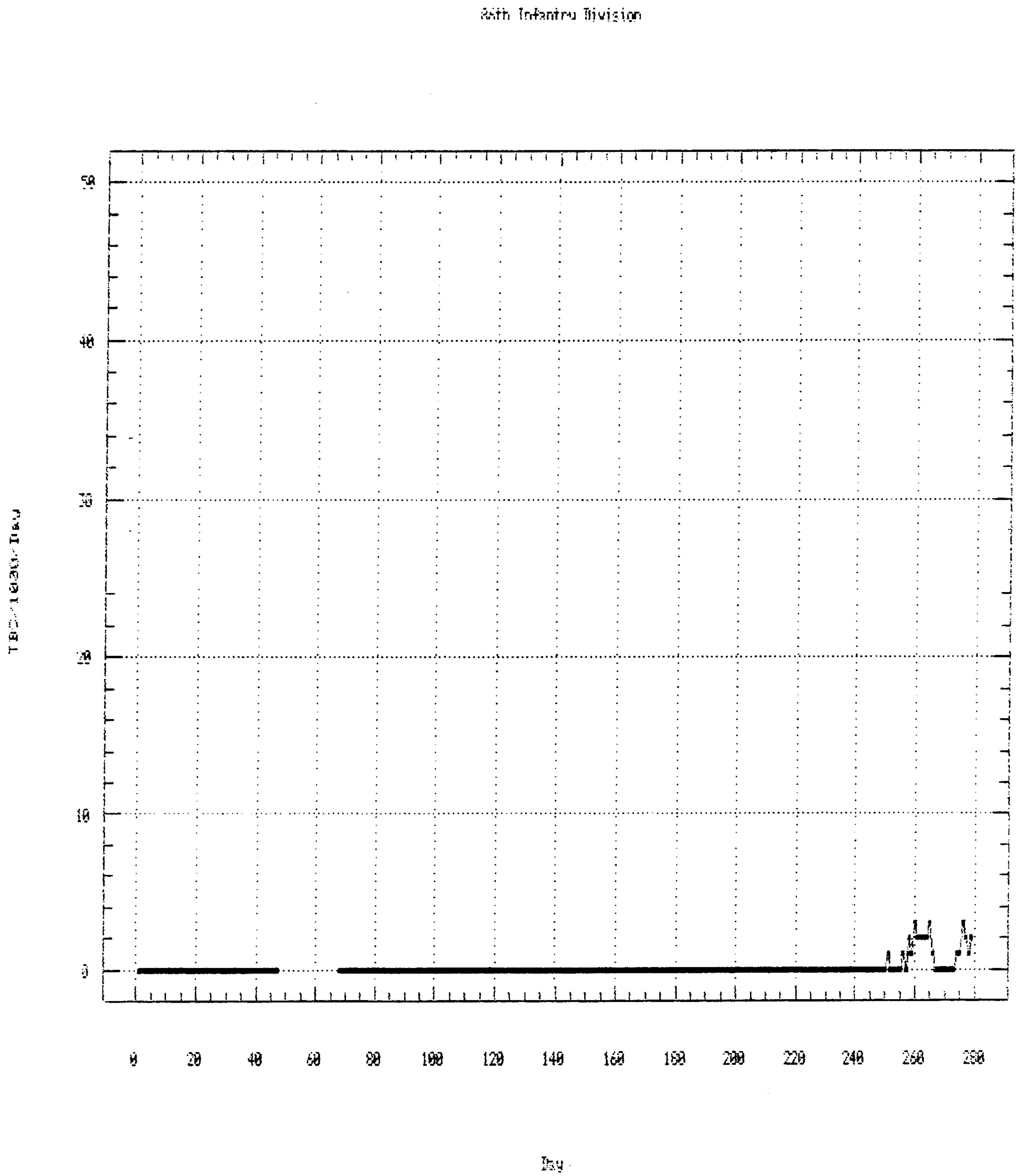
80th Infantry Division



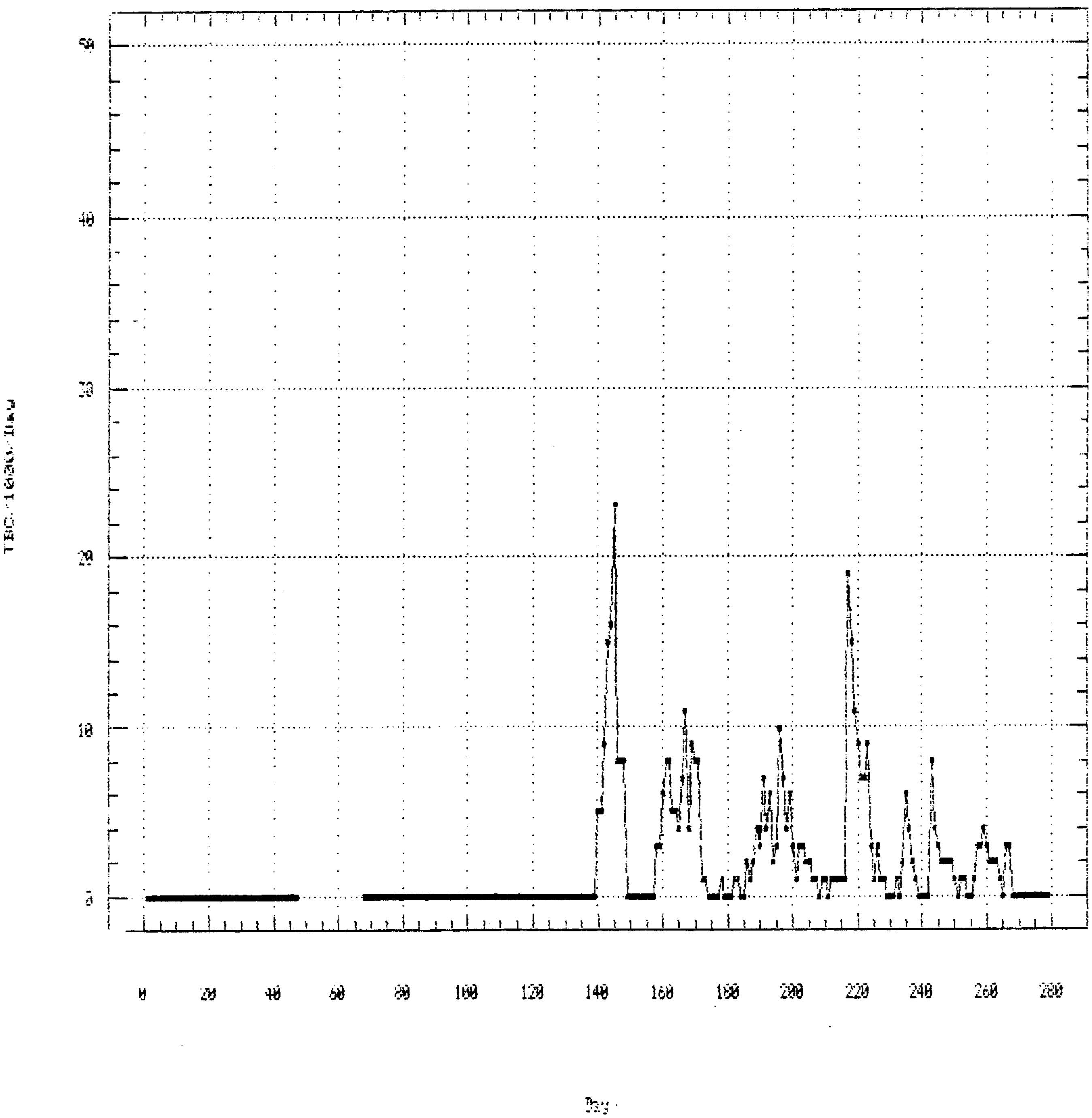
83rd Infantry Division

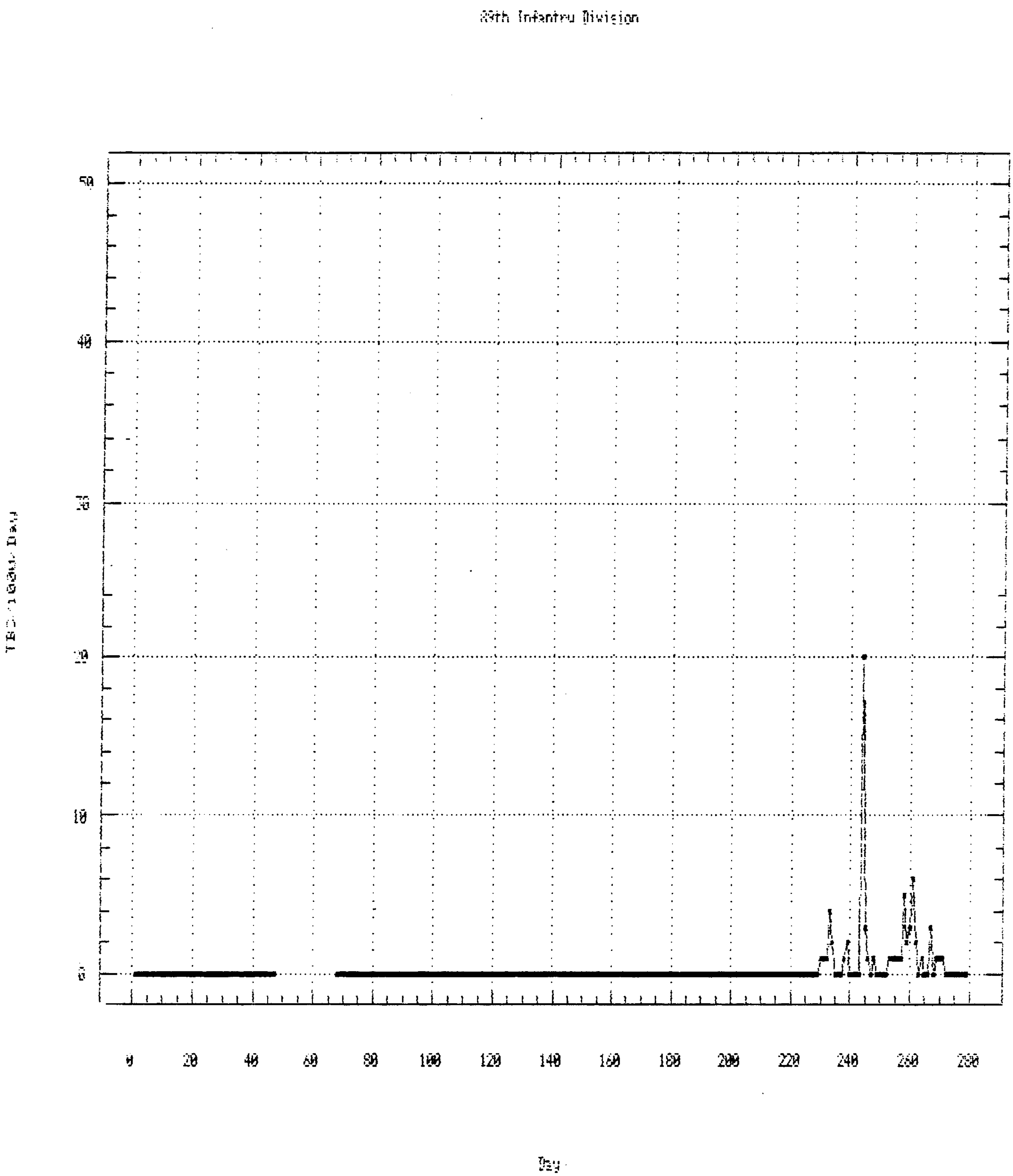



84th Infantry Division
TBD/1000/Day
0
10
20
30
40
50
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

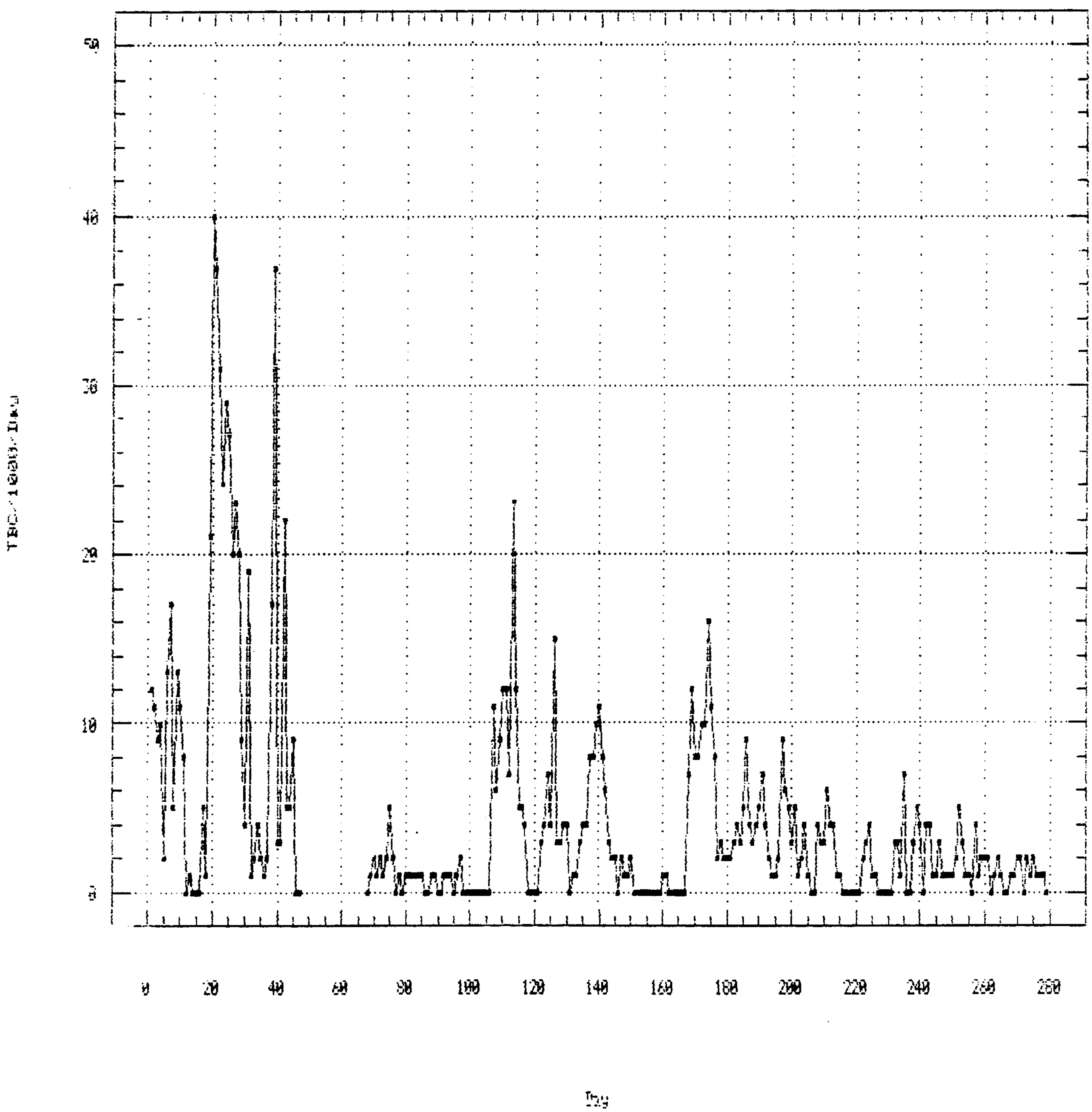

26th Infantry Division
TBS/1000/Day
0
10
20
30
40
50
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

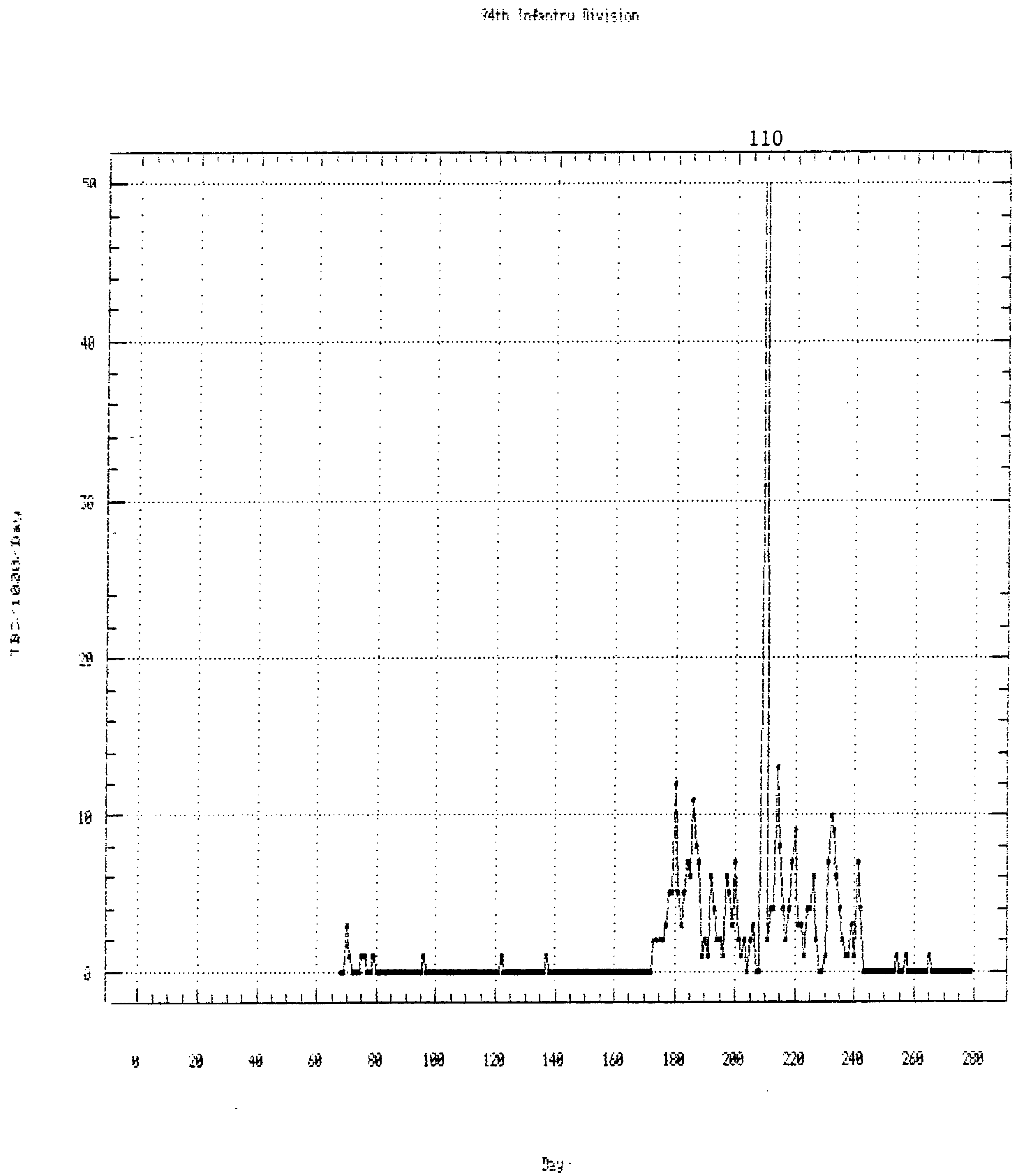
87th Infantry Division



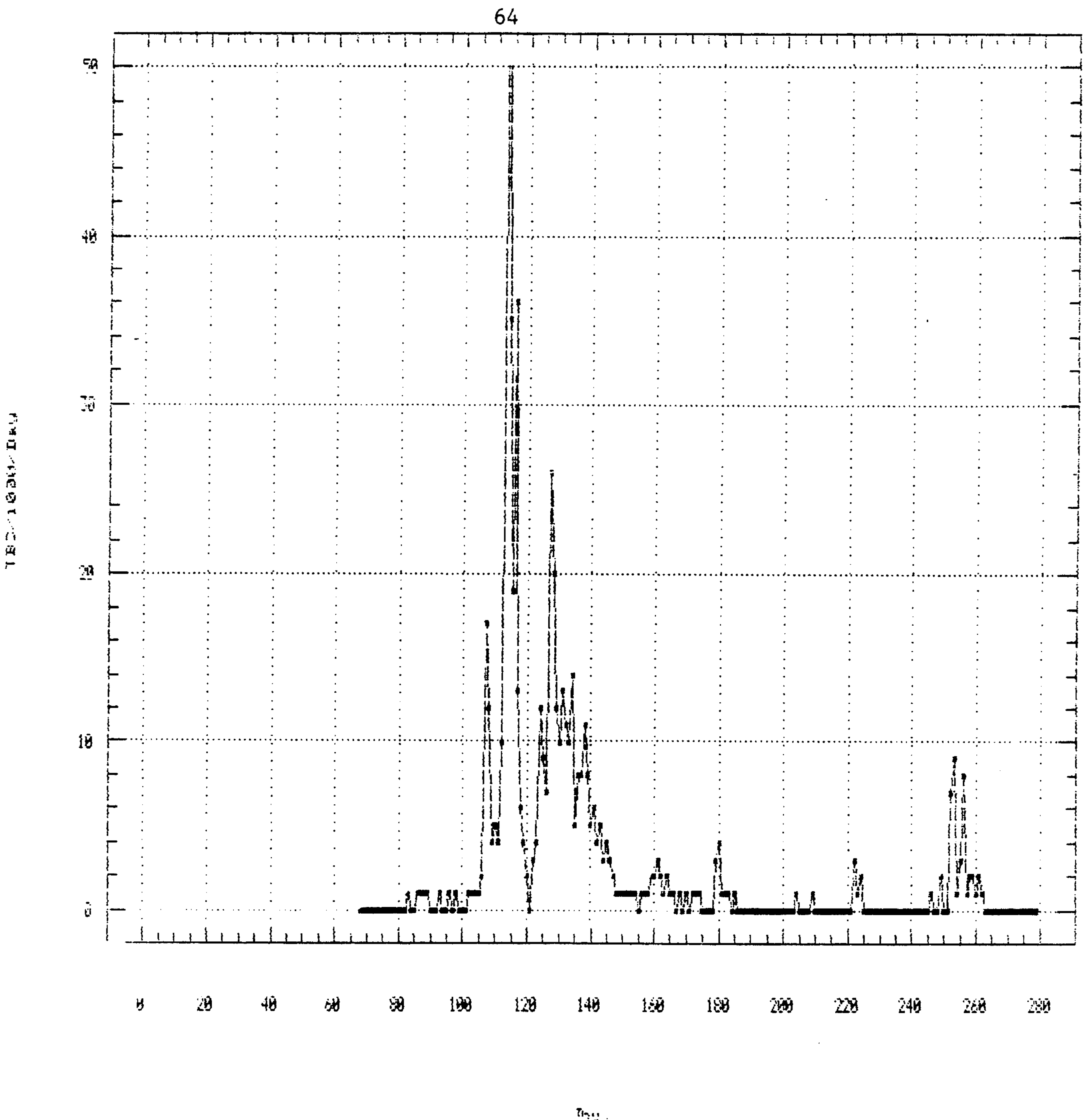

89th Infantry Division
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

90th Infantry Division

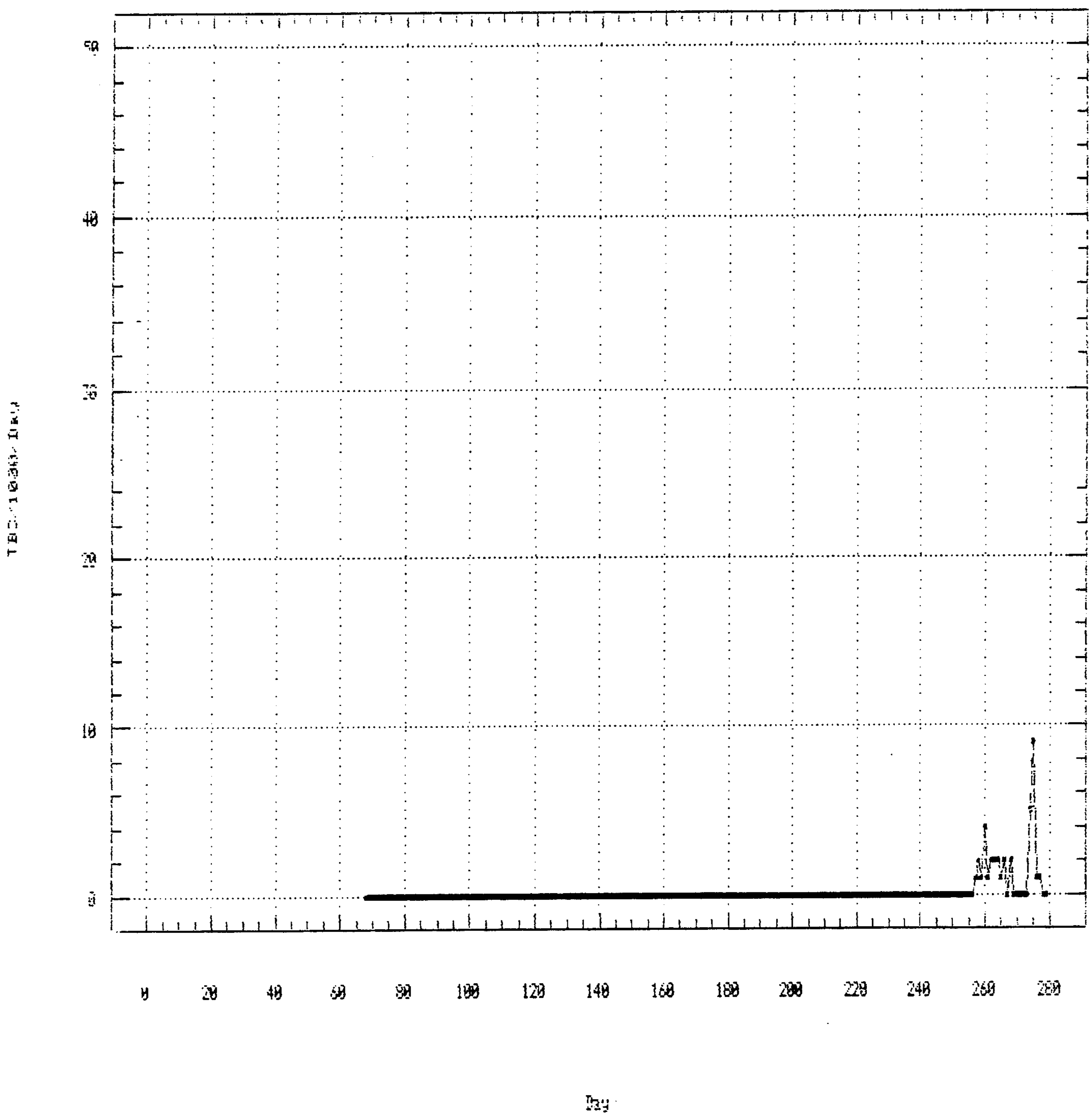



94th Infantry Division
110
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

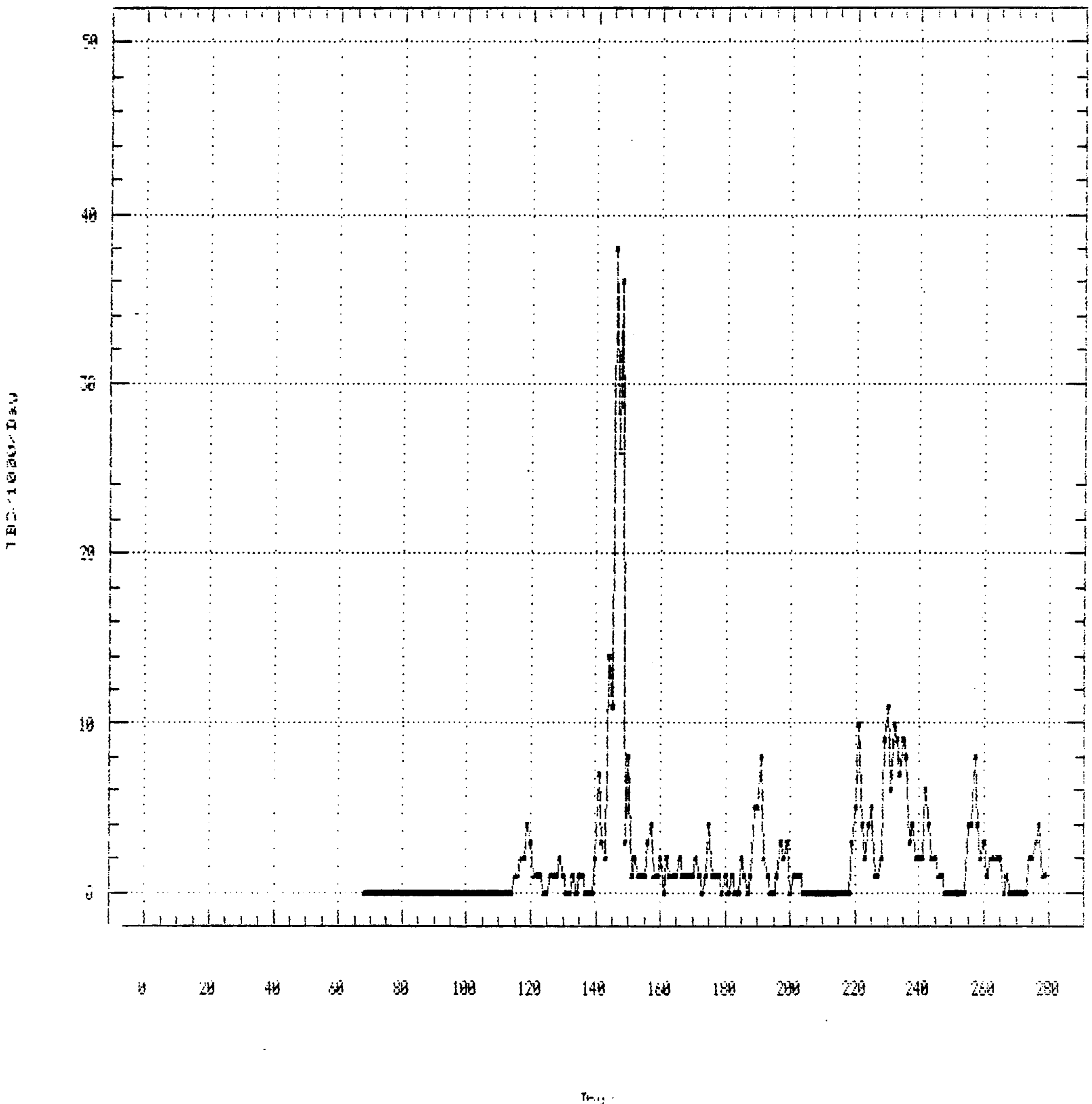
95th Infantry Division



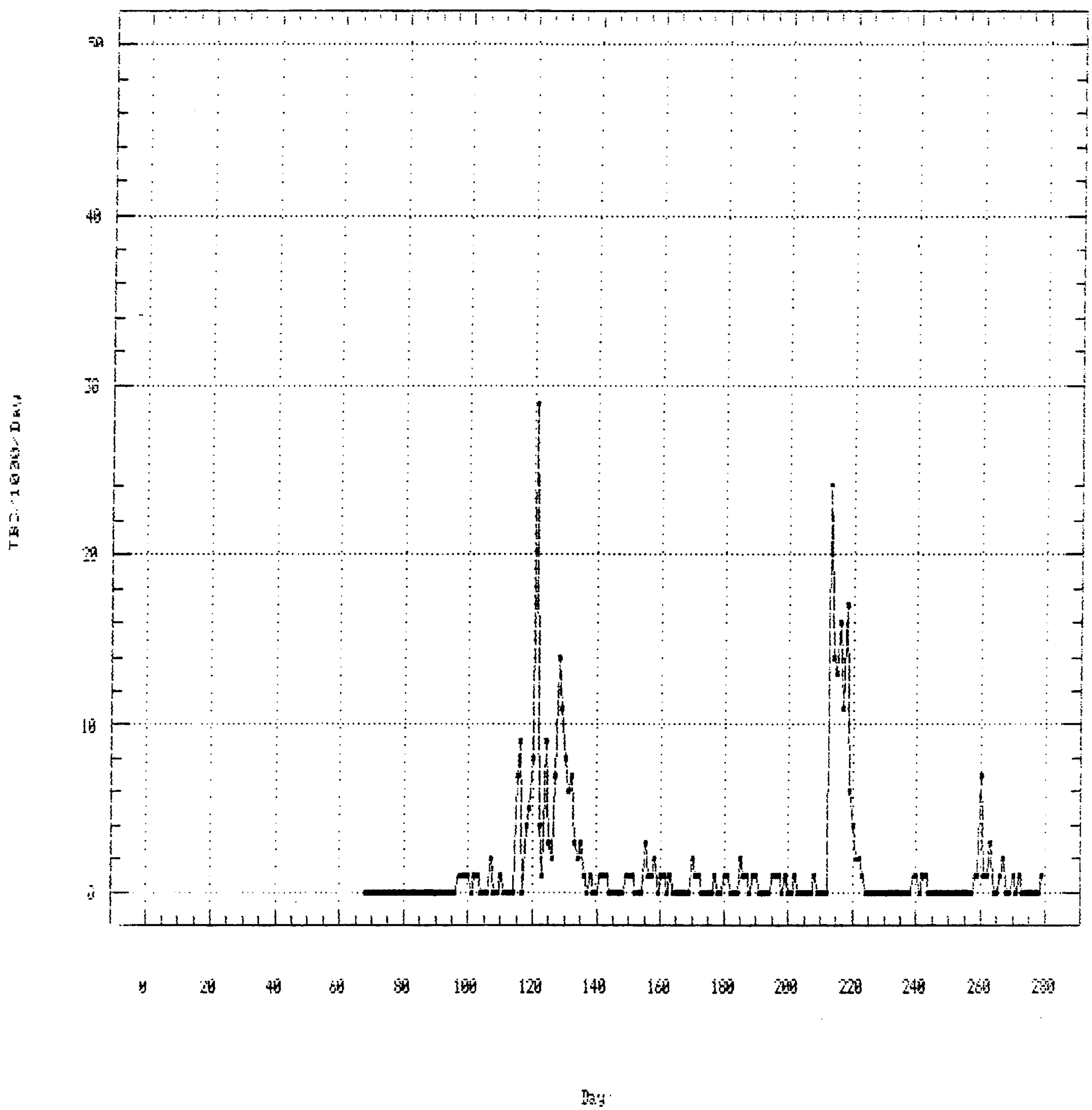
97th Infantry Division



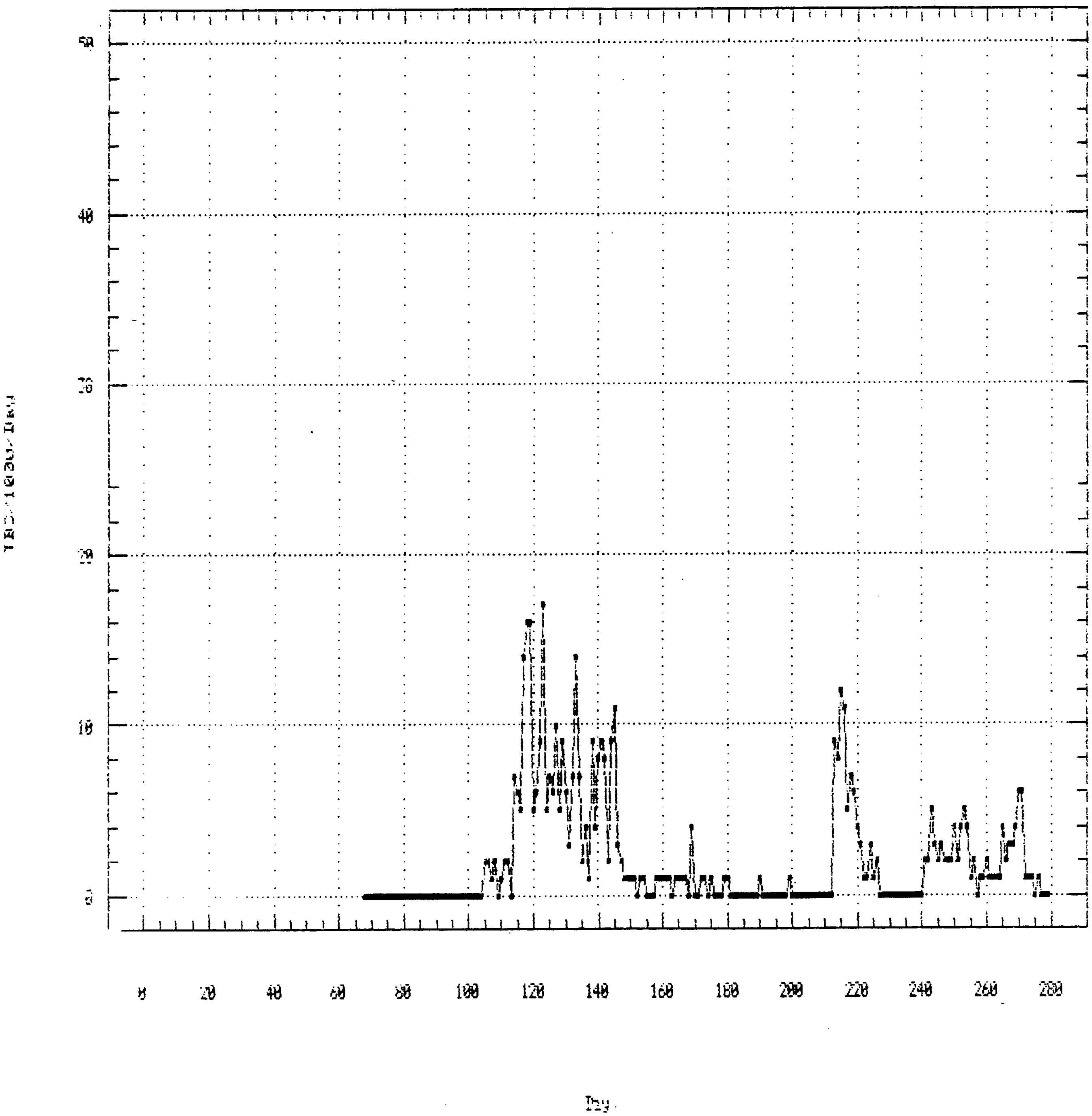
99th Infantry Division



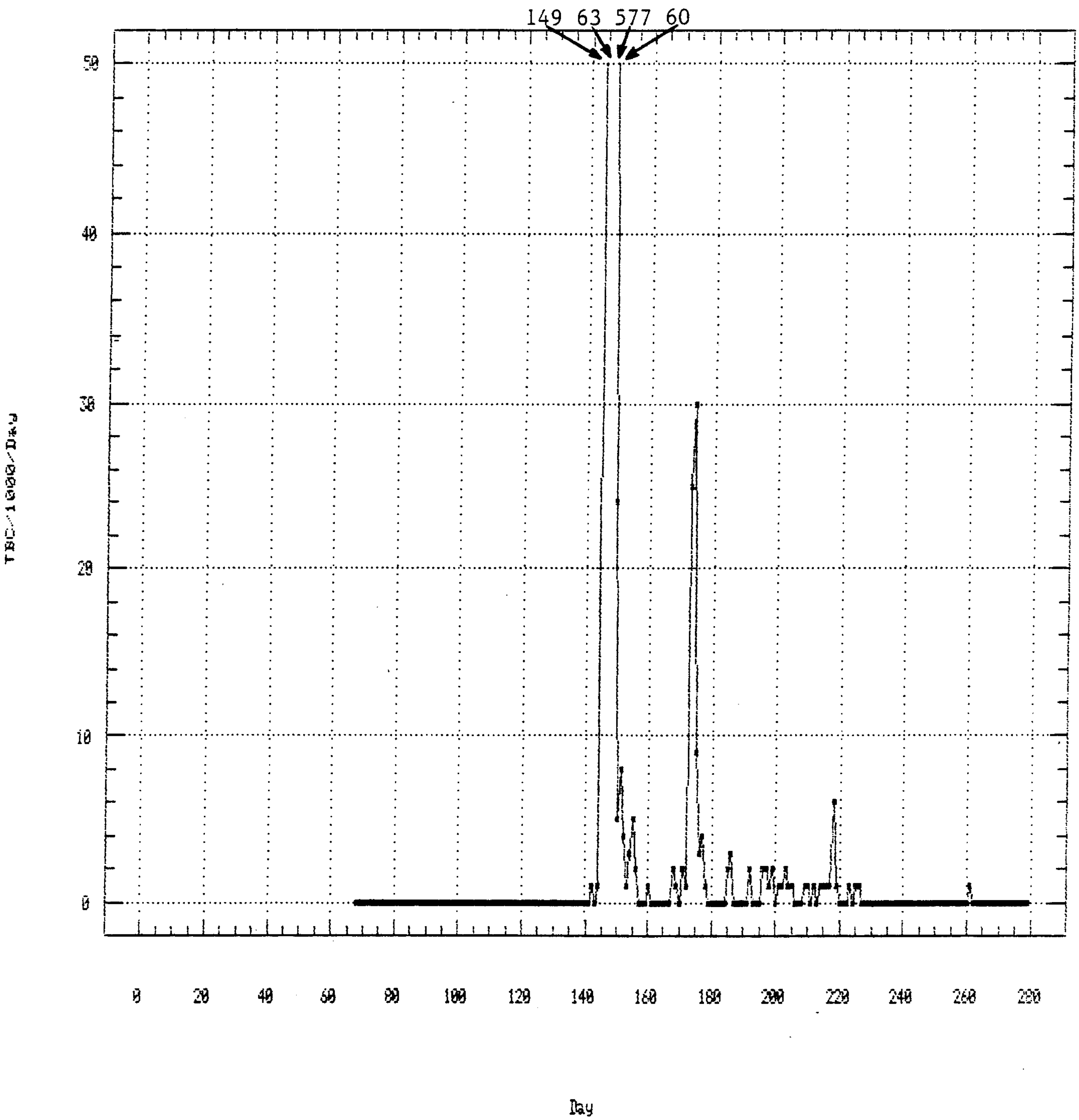
102d Infantry Division



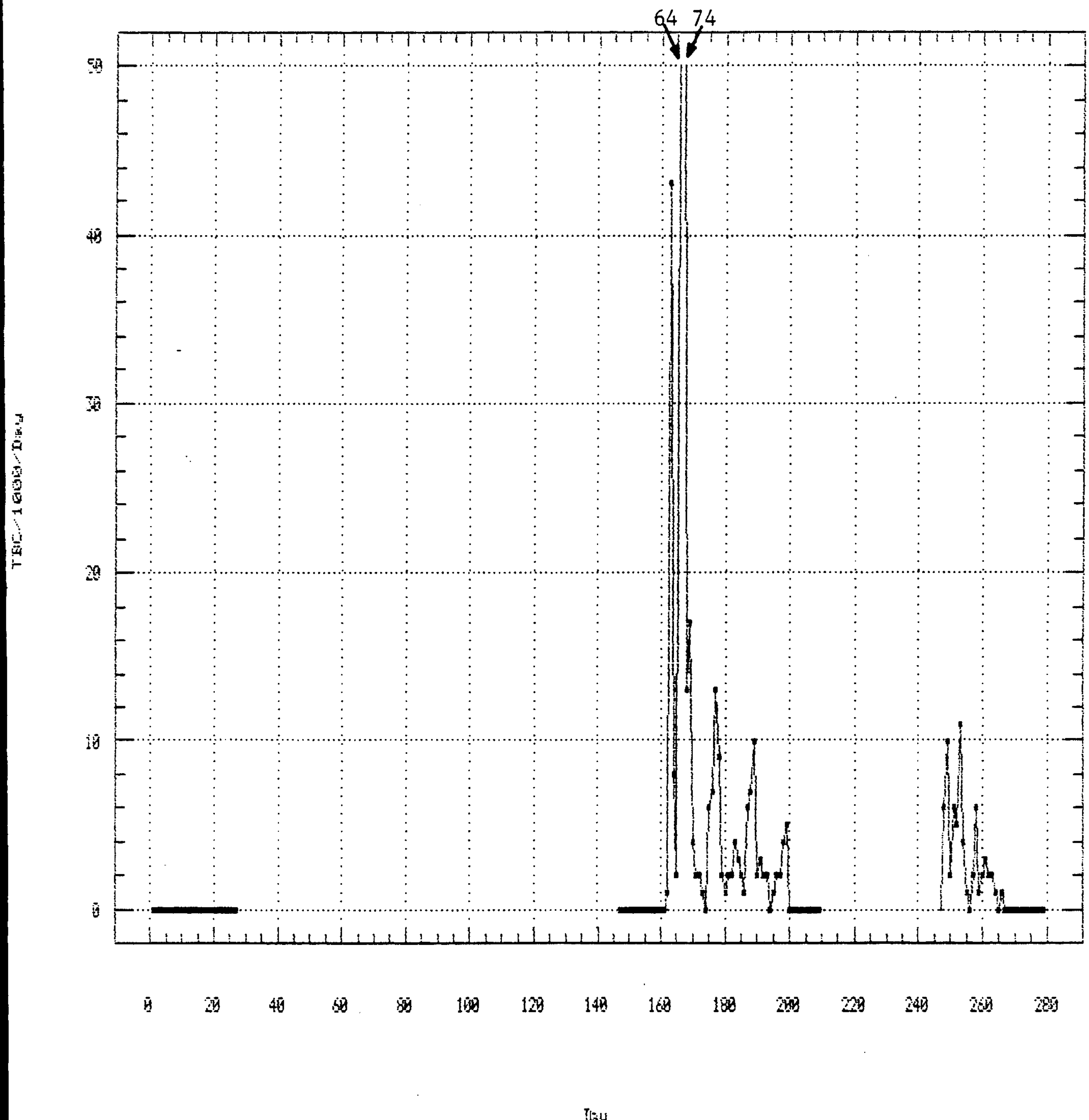
104th Infantry Division



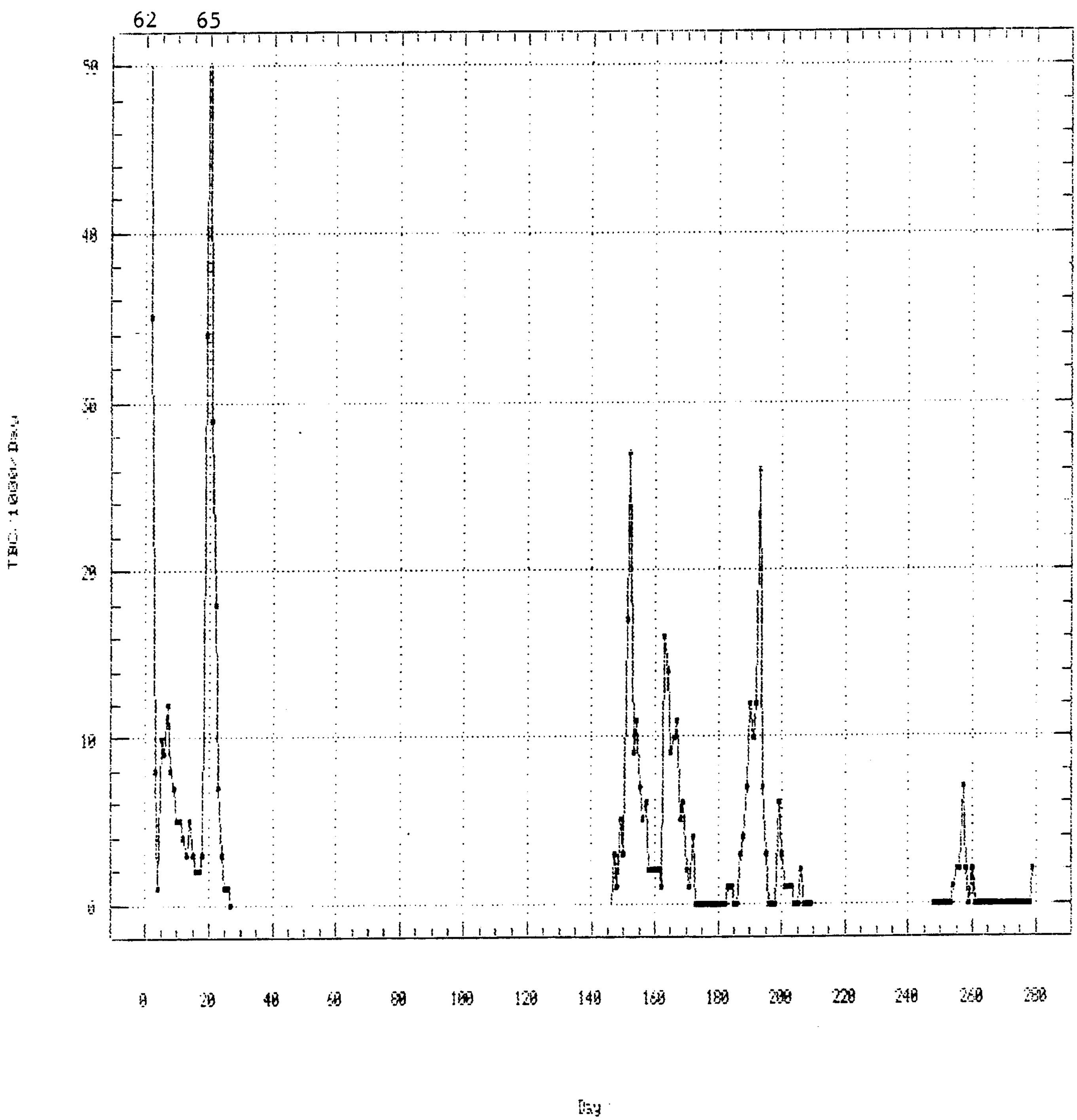
106th Infantry Division



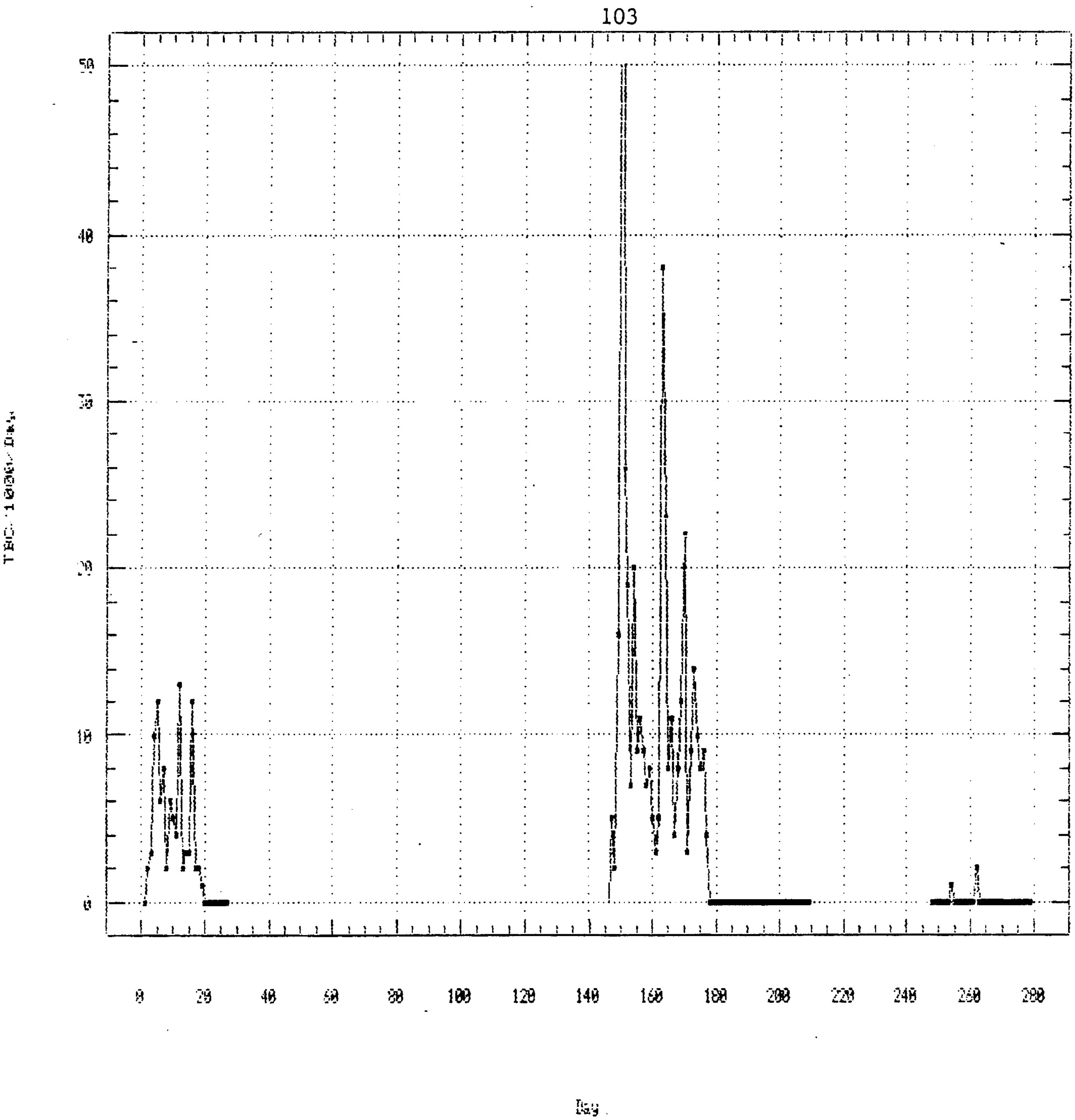
17th Airborne Division



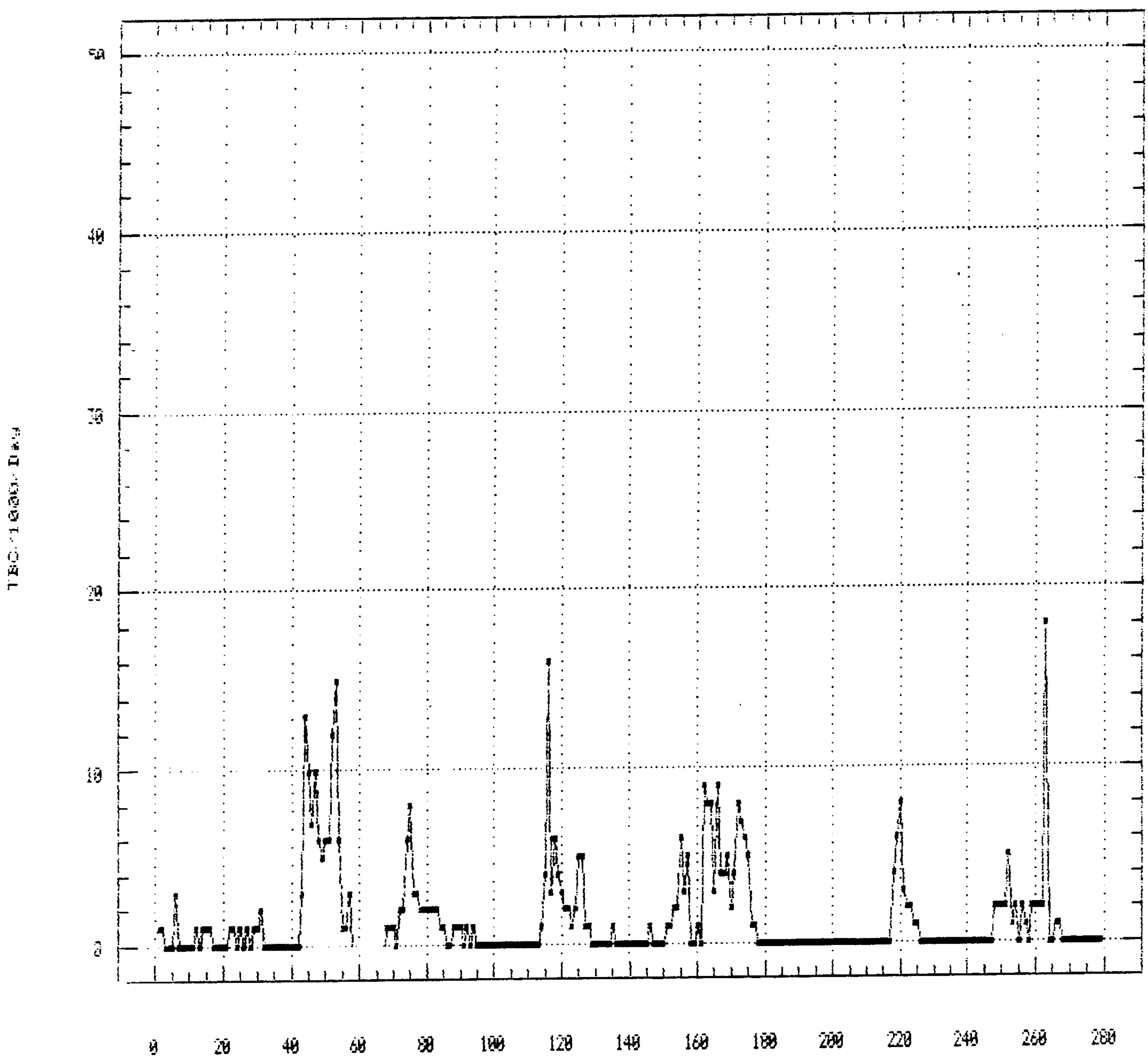
82nd Airborne Division



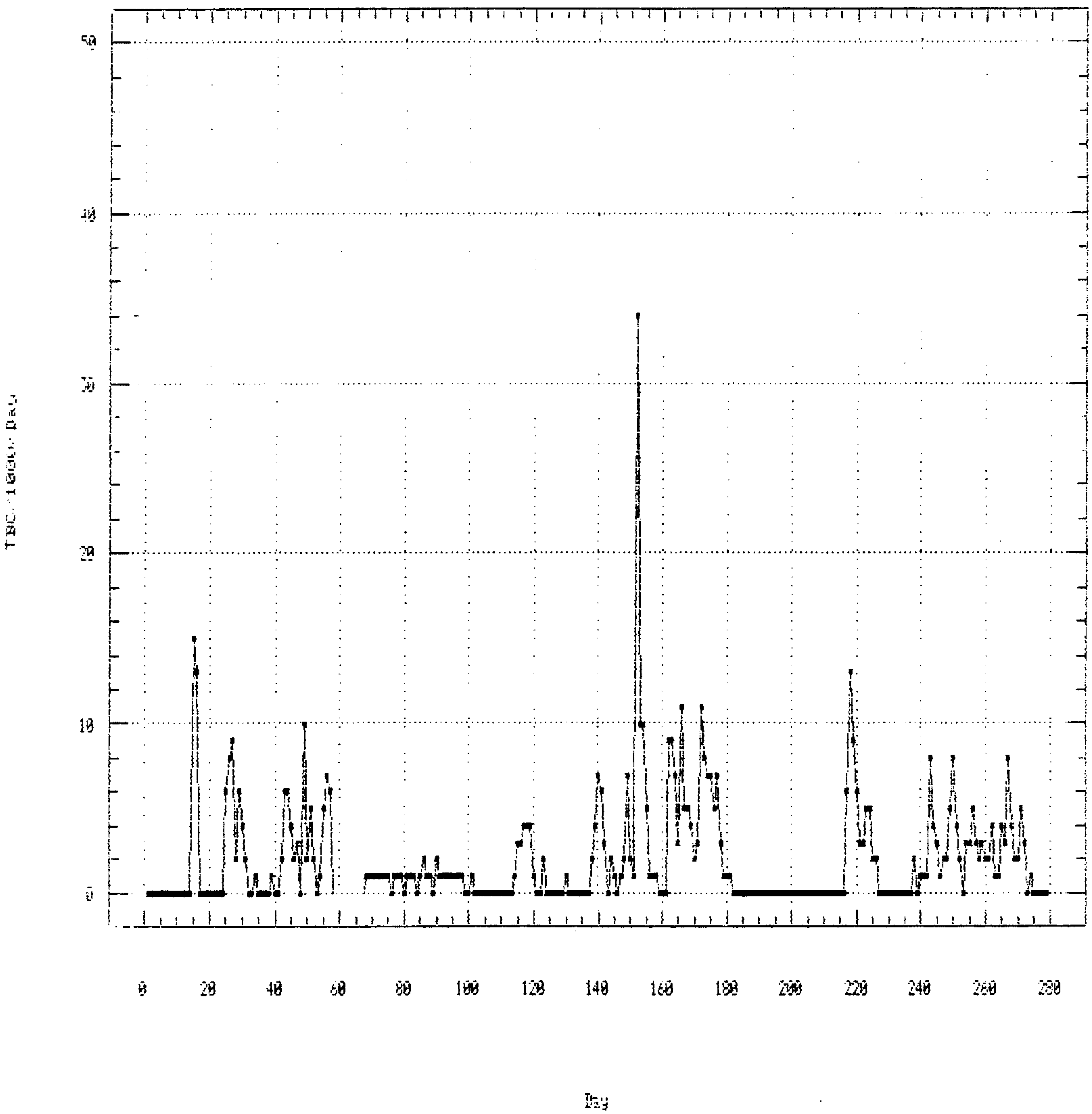
101st Airborne Division



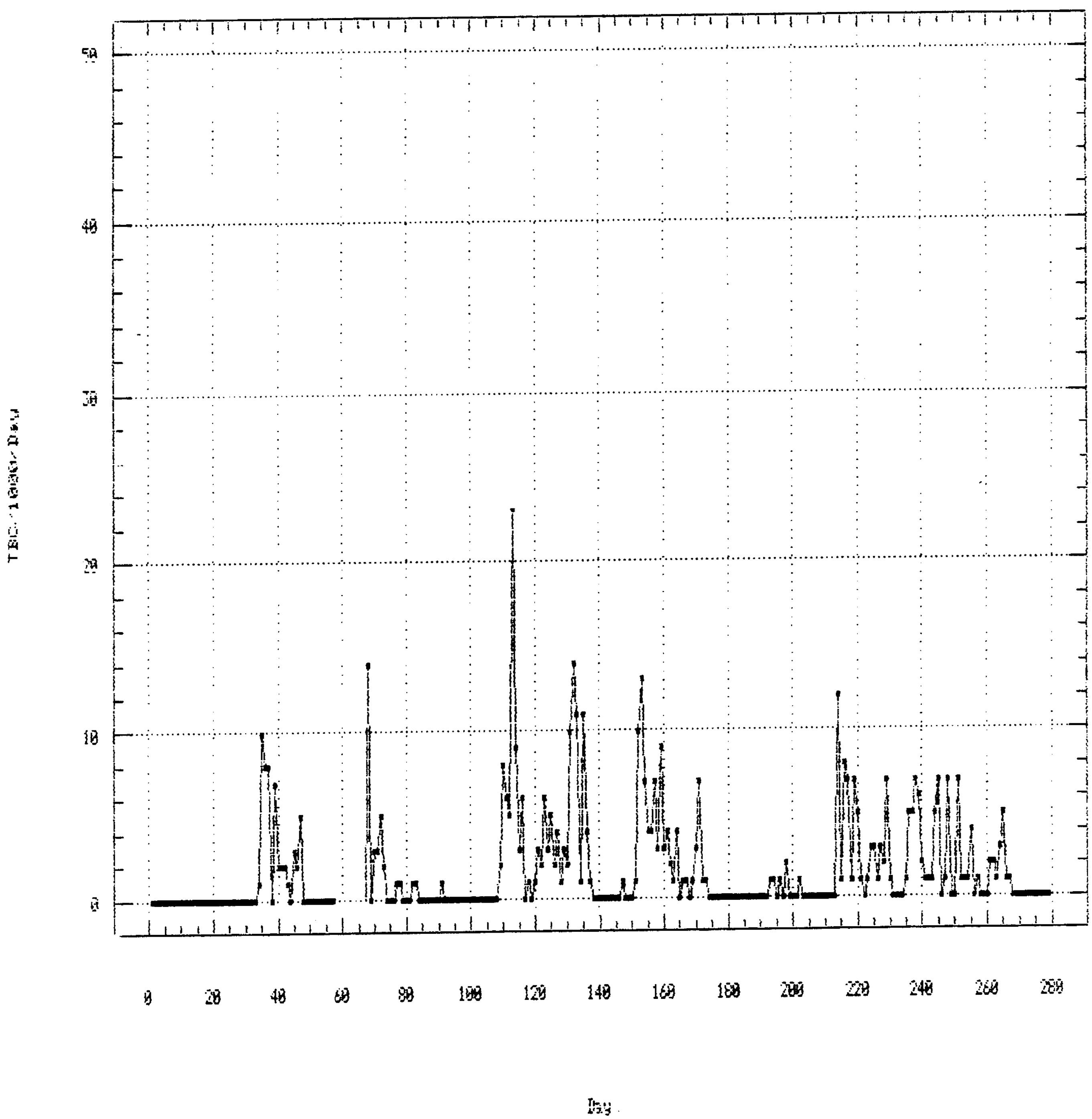
2nd Armored Division



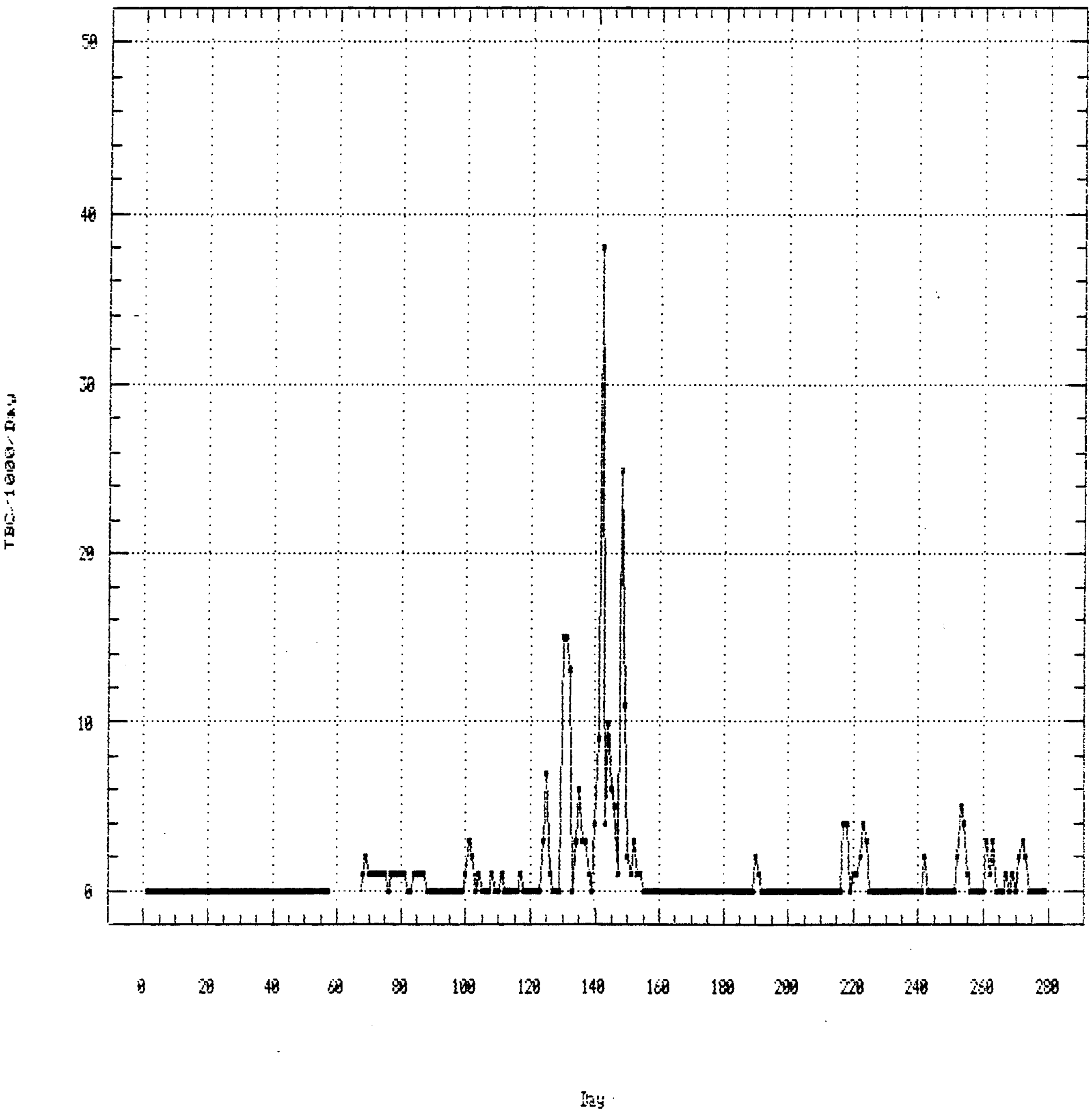
3rd Armored Division



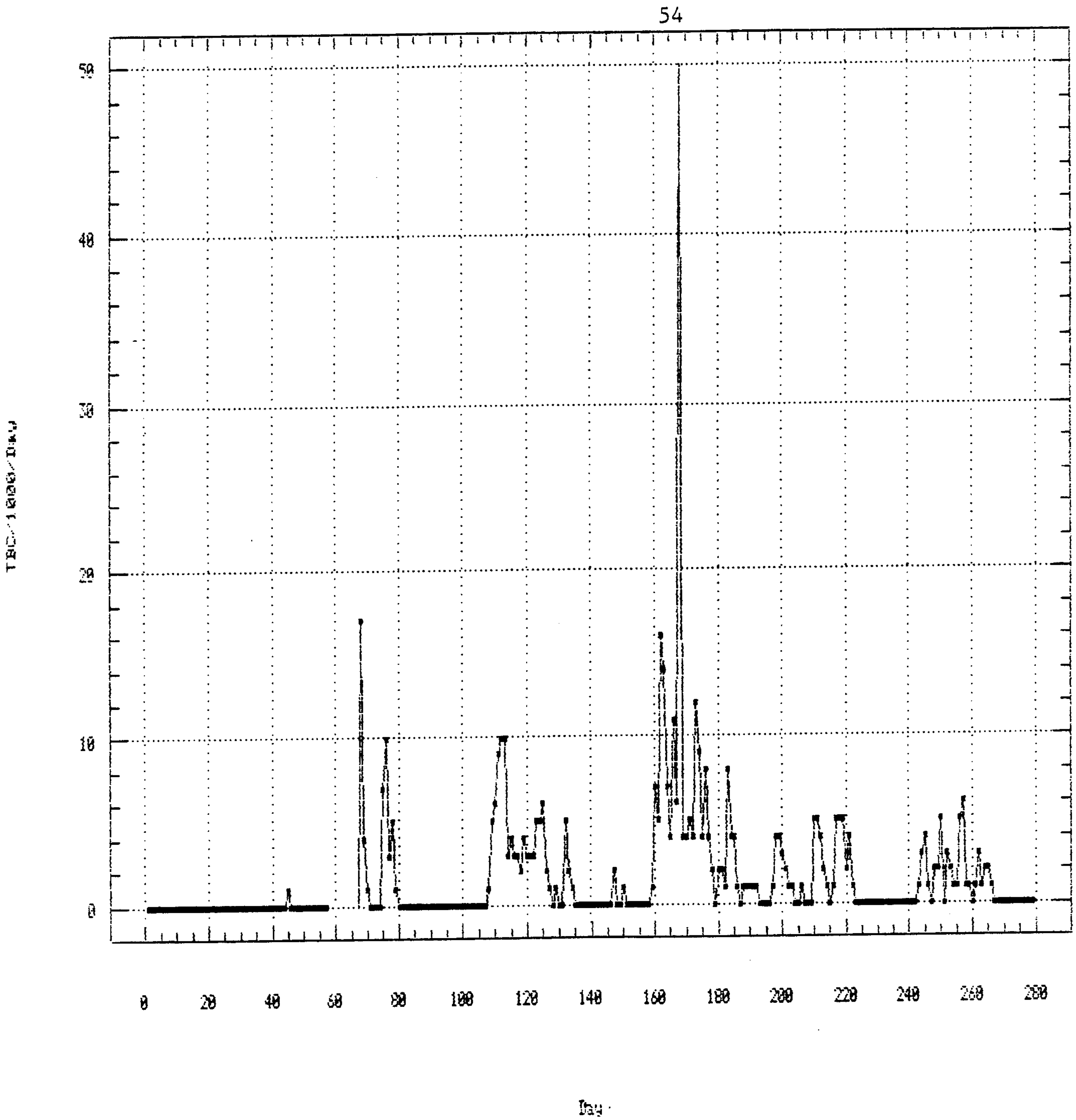
4th Armored Division



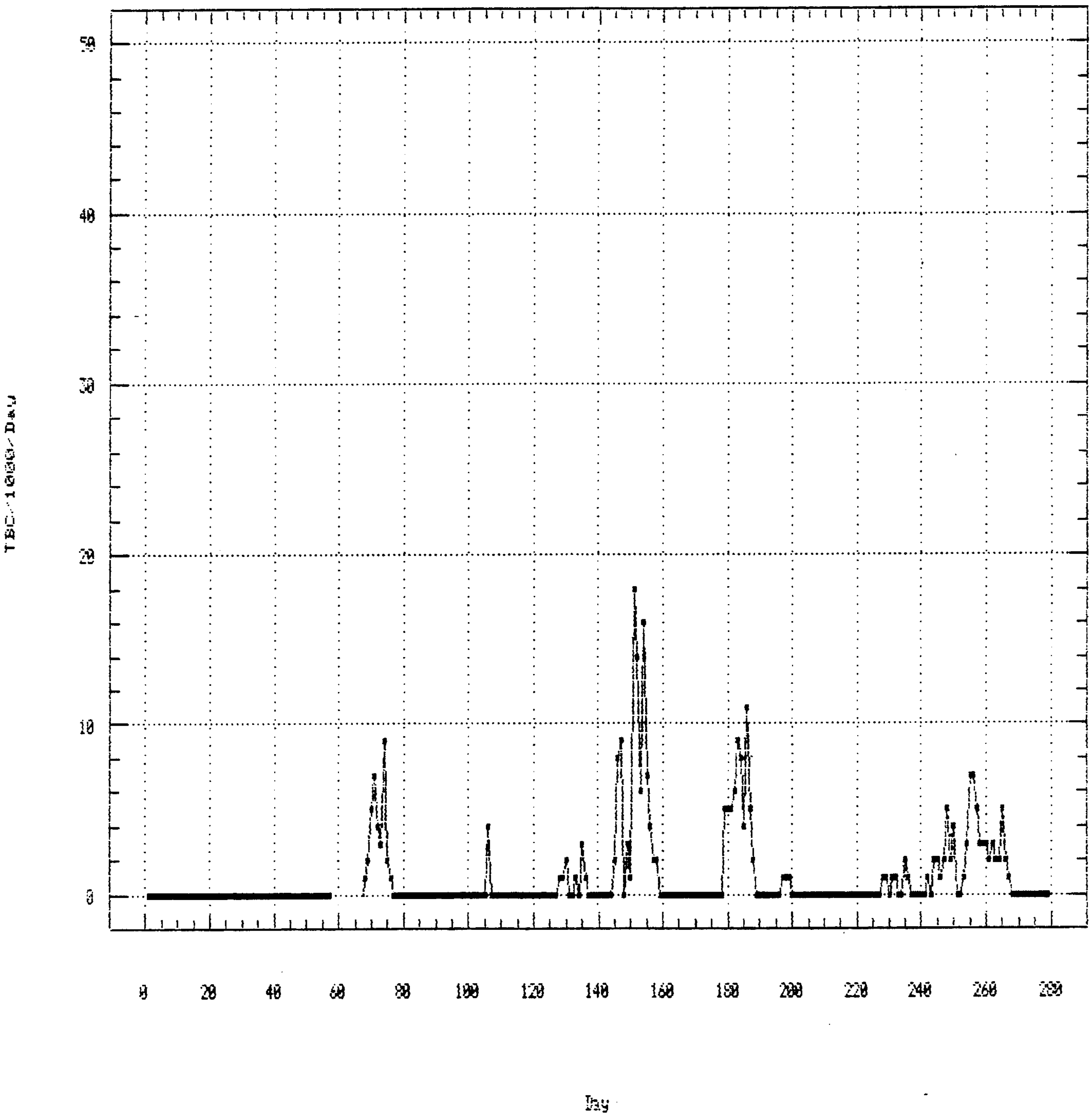
5th Armored Division



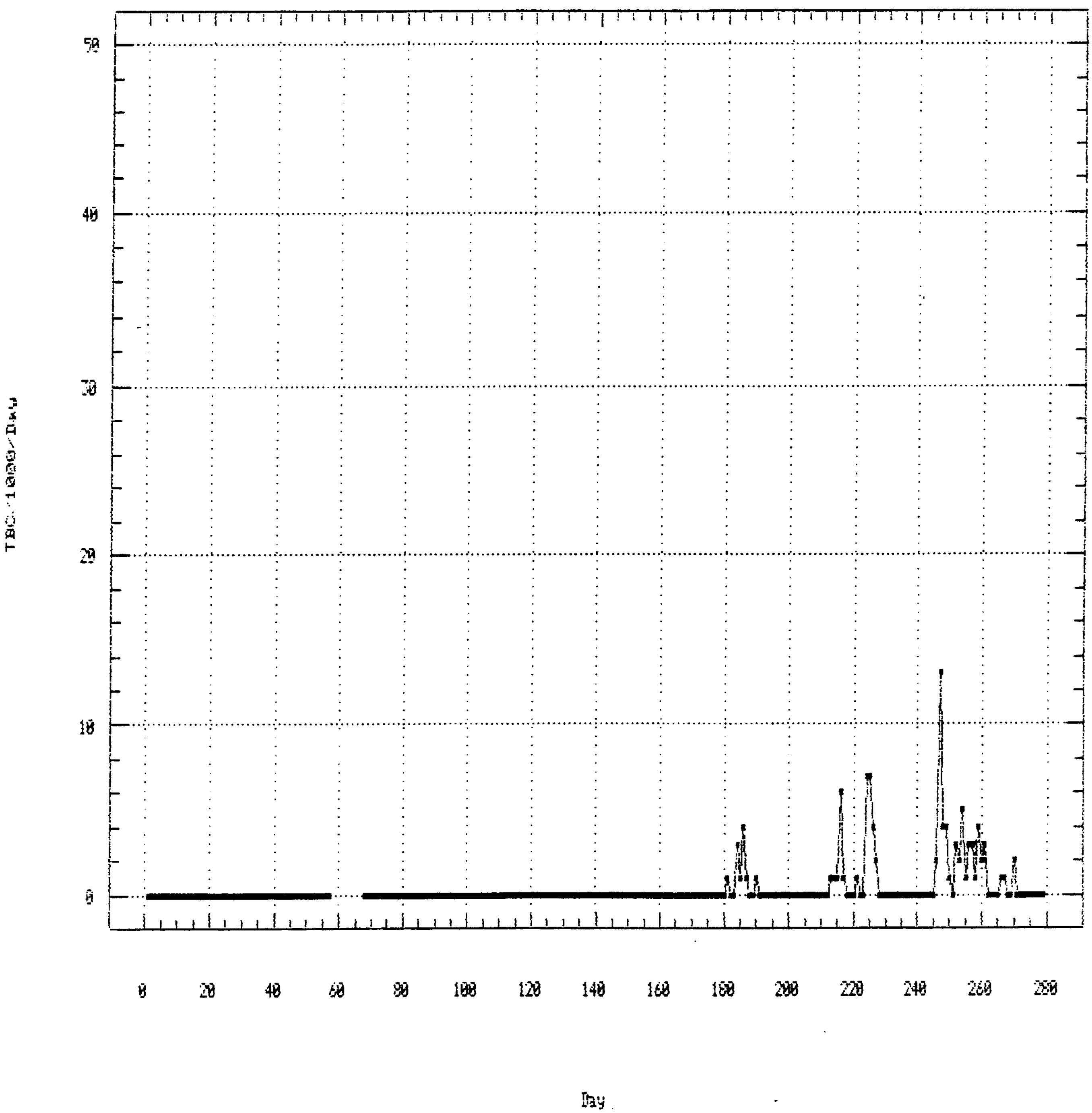
6th Armored Division



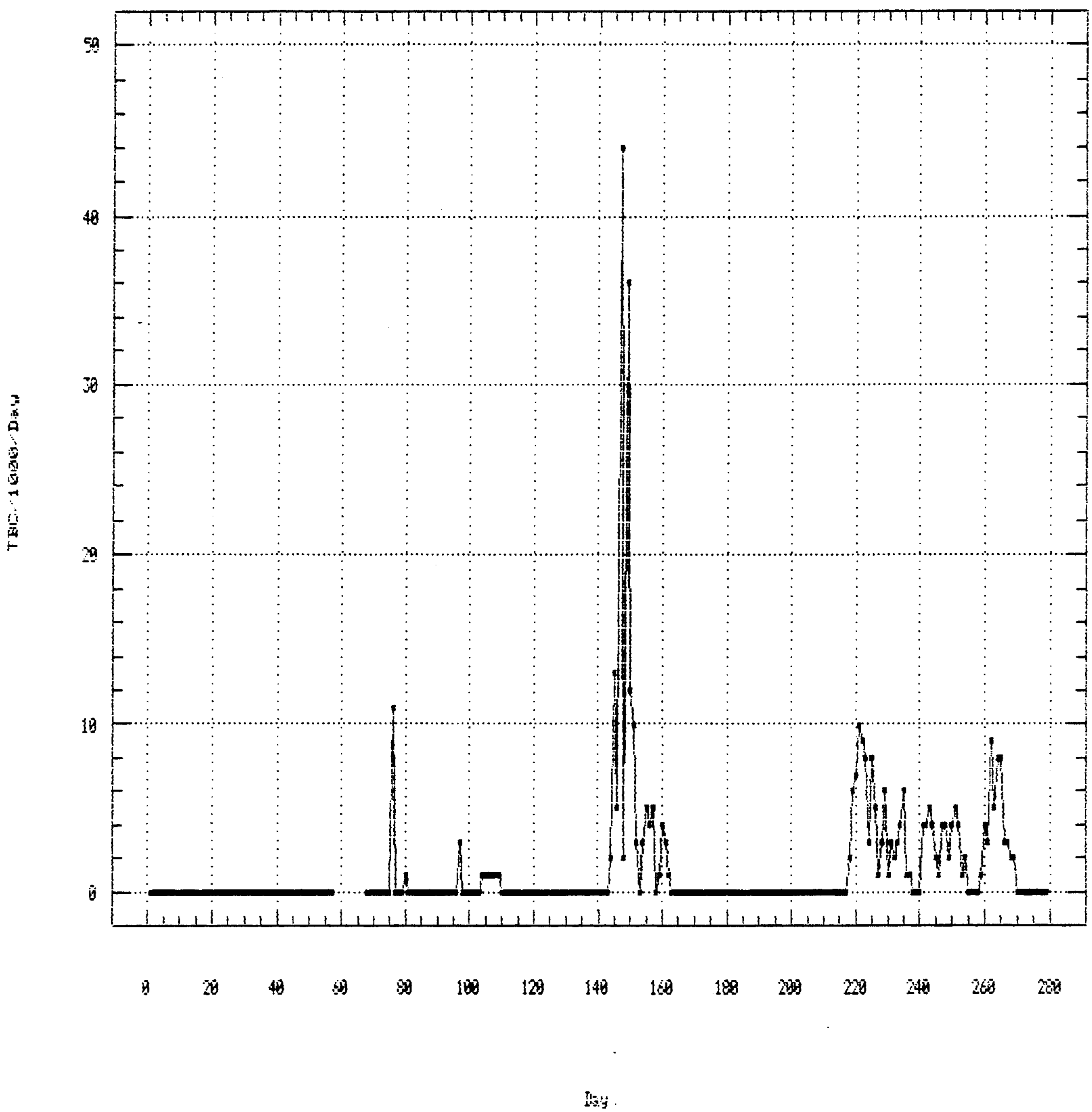
7th Armored Division



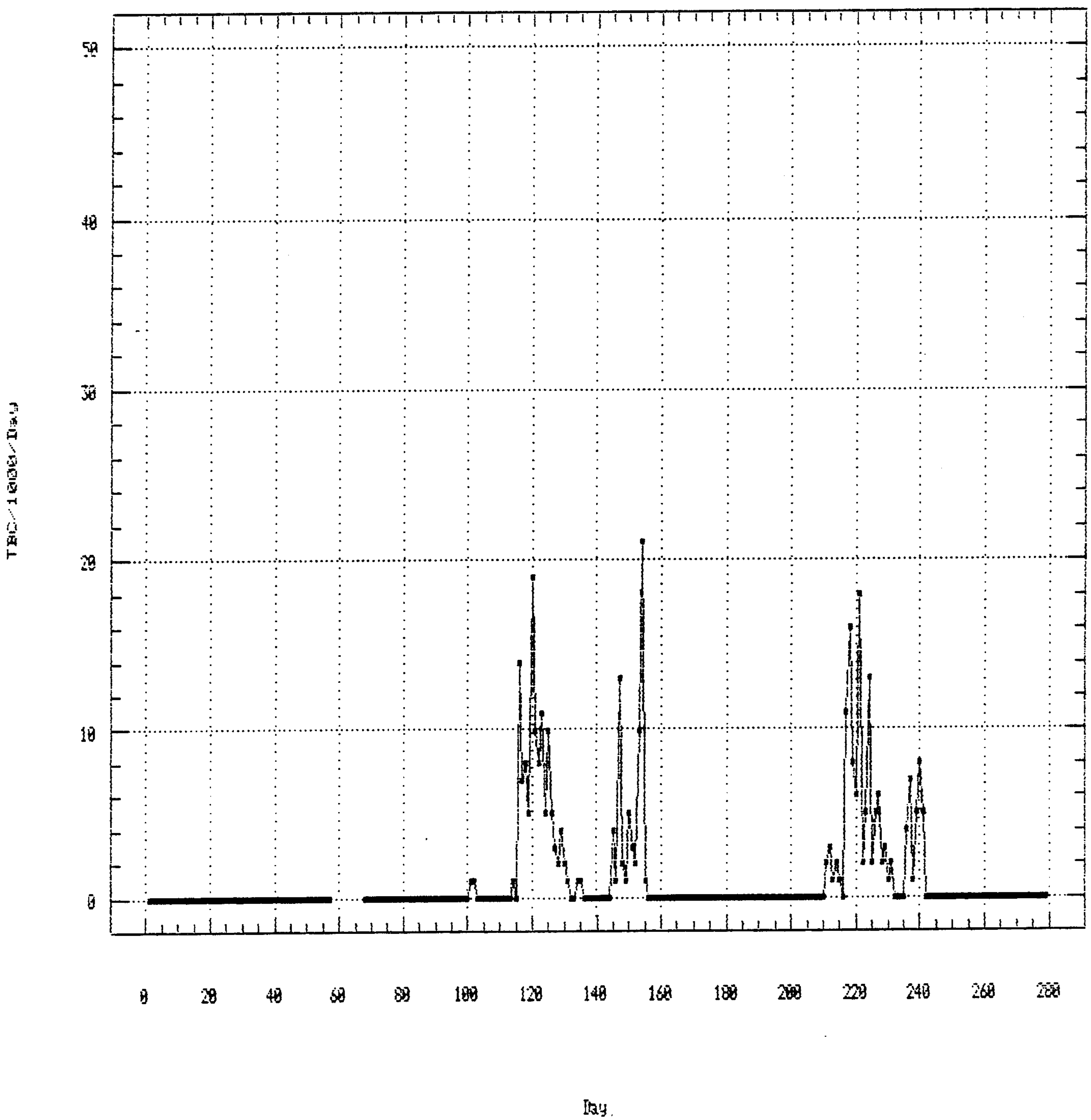
8th Armored Division



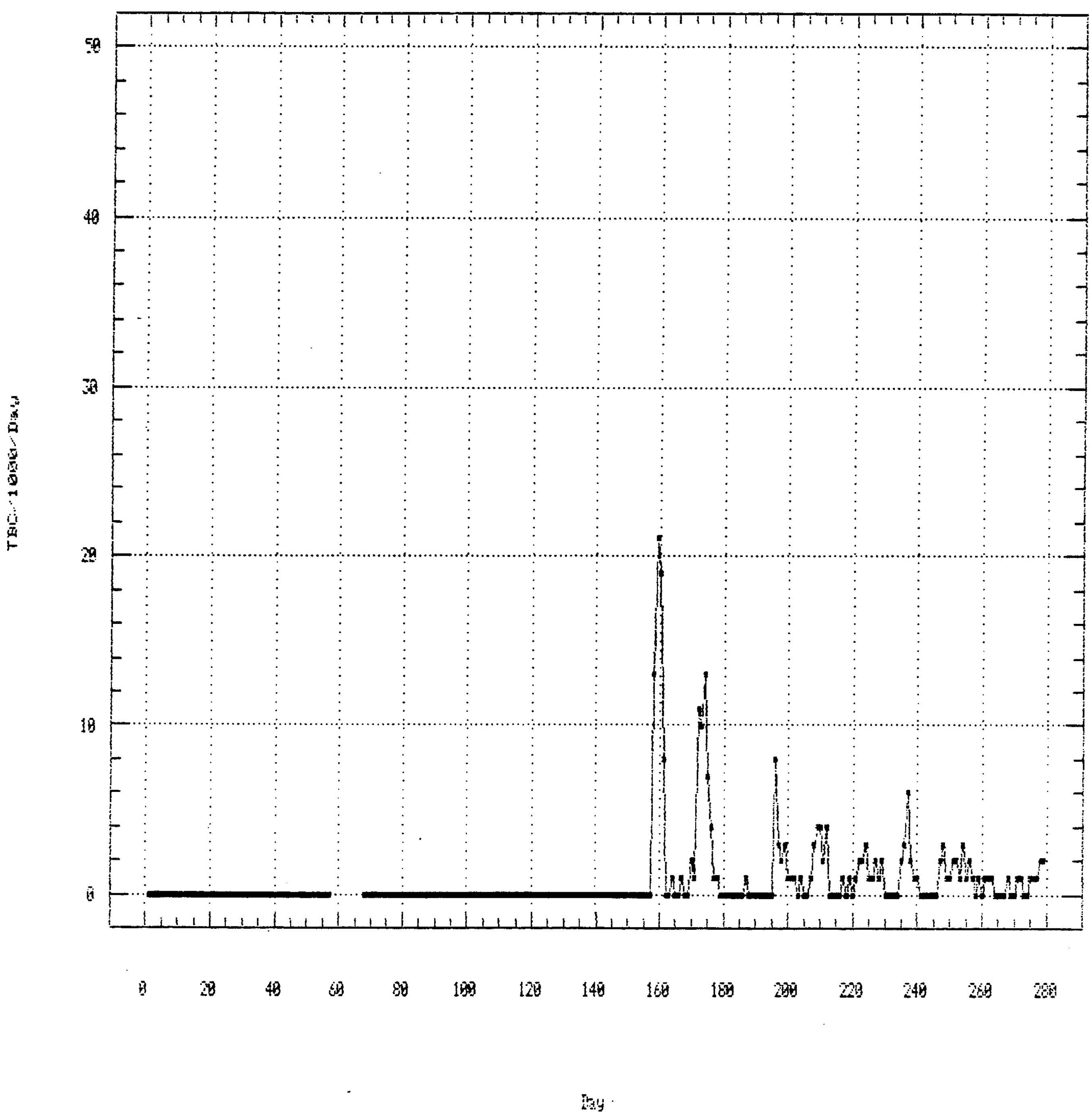
9th Armored Division



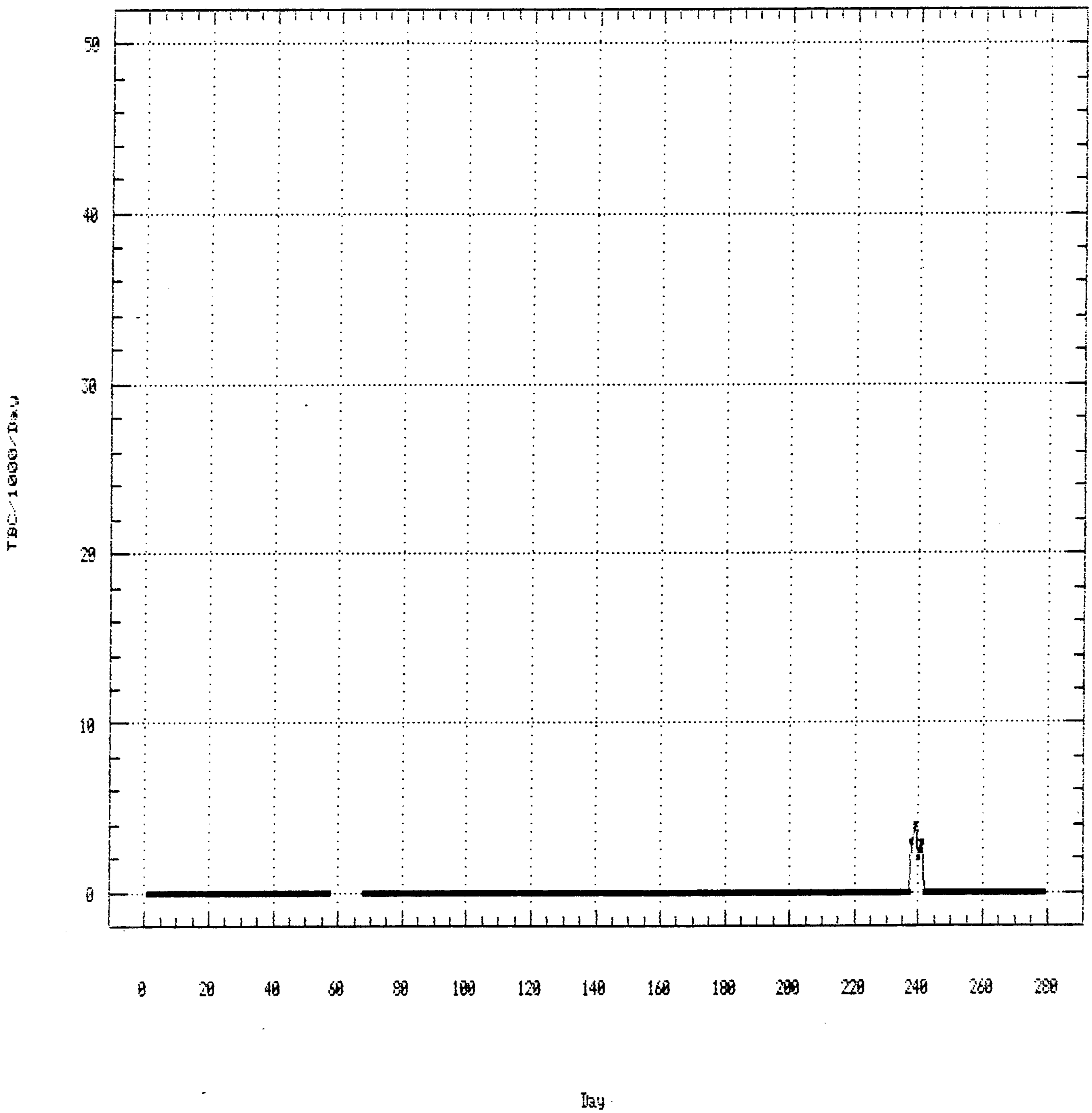
10th Armored Division

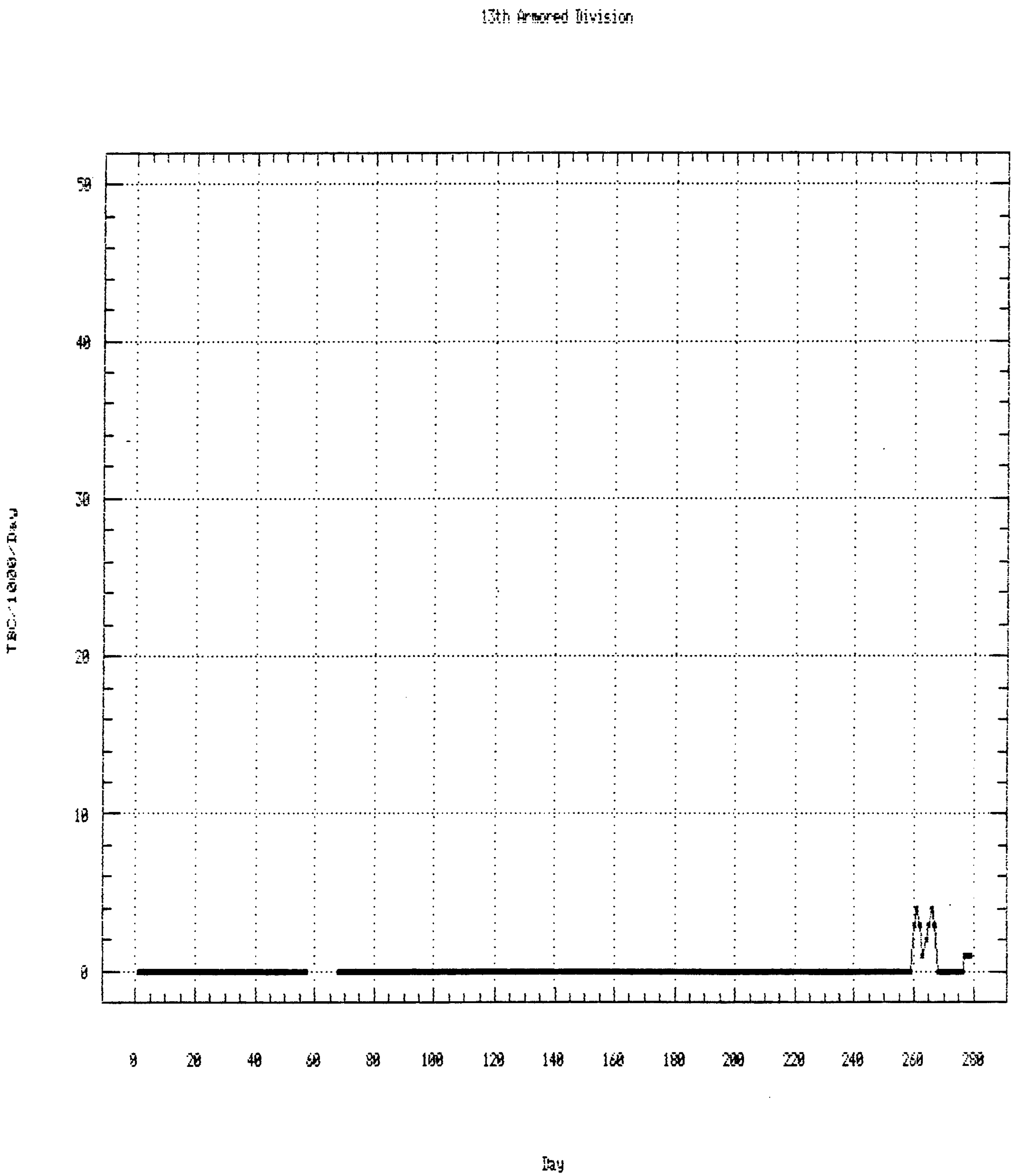


11th Armored Division



12th Armored Division




13th Armored Division
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

ADDENDUM

The 12th Army Group records are not the sole source of data on casualty rates for the Group's subordinate organizations or units. Two other studies have used different sources for casualty data for some of the divisions. This addendum shows the rates provided in the 2 studies where there is some discernible difference when compared to rates in the army group records.

The first study was recently done for the Army's Concepts Analysis Agency by Data Memory Systems, Inc. (DMSI). The task focused on the entire Ardennes Campaign (16 December 1944 to 15 January 1945). DMSI researched a number of sources on U.S. casualty and strength data beyond the 12th Army Group records LMI had previously provided to DMSI.

The second study was completed in 1983 at the Army TRADOC Systems Analysis Agency (TRASANA) by a CPT J. W. Compton. The author researched casualty data in the morning reports of 3 U.S. divisions and their subunits for the fall-winter period of 1944 – 1945. Only in the case of the 7th Armored Division were the morning reports' indicated cumulative casualties significantly different than those indicated in the army group records for the particular period (17 – 23 December 1944).

DIVISION	DATE	12AGp	OMSI	DIFFERENCE
1st ID	01/15/45	1	20	+ 19
1st ID	01/16/45	9	15	+ 6
2d ID	12/17/44	10	20	+ 10
2d ID	12/18/44	12	25	+ 13
2d ID	12/19/44	6	24	+ 18
2d ID	12/20/44	4	41	+ 37
5th ID	12/27/44	15	21	+ 6
26th ID	01/04/45	15	18	+ 3
28th ID	12/18/44	50	55	+ 5
28th ID	12/19/44	54	60	+ 6
28th ID	12/20/44	53	99	+ 46
28th ID	12/26/44	0	11	+ 11
28th ID	01/08/45	5	22	+ 17
30th ID	12/20/44	12	24	+ 12
30th ID	01/13/45	1	14	+ 13
30th ID	01/14/45	12	19	+ 7
30th ID	01/15/45	32	21	− 11
75th ID	12/26/44	10	12	+ 2
75th ID	12/28/44	11	13	+ 2
80th ID	12/26/44	22	36	+ 14
80th ID	12/28/44	6	13	+ 7
83d ID	12/15/44	20	16	− 4
83d ID	12/16/44	31	10	− 21
83d ID	12/17/44	19	9	− 10
83d ID	12/20/44	14	3	− 11
83d ID	01/04/45	16	3	− 13
83d ID	01/09/45	6	11	+ 5
83d ID	01/10/45	11	20	+ 9
83d ID	01/11/45	12	8	− 4
83d ID	01/13/45	21	13	− 8
83d ID	01/15/45	16	25	+ 9
83d ID	01/16/45	21	13	− 8
99th ID	12/18/44	38	52	+ 14
99th ID	12/19/44	26	33	+ 7
99th ID	12/20/44	36	33	− 3
99th ID	12/24/44	2	17	+ 15

DIVISION	DATE	12AGp	DMSI	DIFFERENCE
106th ID	12/17/44	149	34*	-115
106th ID	12/18/44	63	23*	- 40
106th ID	12/19/44	577*	560*	- 17
106th ID	12/20/44	60	78*	+ 18
106th ID	01/14/45	25	67*	+ 42
106th ID	01/15/45	30	48*	+ 18
17th AbnD	01/07/45	64	91	+ 27
17th AbnD	01/08/45	74	88	+ 14
17th AbnD	01/09/45	13	15	+ 2
17th AbnD	01/10/45	17	20	+ 3
82d AbnD	12/23/44	17	10	- 7
82d AbnD	12/24/44	27	16	- 11
82d AbnD	12/26/44	11	6	- 5
82d AbnD	01/03/45	1	38	+ 37
82d AbnD	01/04/45	16	22	+ 6
82d AbnD	01/05/45	14	9	- 5
82d AbnD	01/08/45	11	7	- 4
101st AbnD	12/19/44	5	19	+ 14
101st AbnD	12/21/44	16	9	- 7
101st AbnD	12/22/44	103	62	- 41
101st AbnD	12/23/44	26	18	- 8
101st AbnD	12/24/44	19	13	- 6
101st AbnD	12/26/44	20	14	- 6
101st AbnD	12/28/44	11	7	- 4
3d AD	12/24/44	34	4	- 30
3d AD	12/25/44	10	13	+ 3
6th AD	01/09/45	54	10	- 44
7th AD	12/24/44	14	19	+ 5
7th AD	12/25/44	6	28	+ 22
7th AD	12/26/44	16	27	+ 11
9th AD	12/21/44	36	26	- 10
9th AD	12/22/44	12	8	- 4
9th AD	12/26/44	3	51	+ 48
10th AD	12/22/44	5	18	+ 13
10th AD	12/23/44	3	16	+ 13
10th AD	12/26/44	21	43	+ 22

* Imputed only (reconstructed)

7th Armored Division:
12th Army Group Records versus Trasana Study (and DMSI)

DATE	12AGp	TRASANA	DIFFERENCE	DMSI
12/17/44	1.88	0.85	- 1.03	1.88
12/18/44	7.86	6.44	- 1.42	7.86
12/19/44	8.80	0.57	- 8.23	8.80
12/20/44	0.40	1.59	+ 1.19	0.38
12/21/44	2.66	21.44	+18.78	2.70
12/22/44	0.95	9.20	+ 8.25	0.97
12/23/44	17.83	12.81	- 5.02	18.50

APPENDIX C

EXAMPLES OF GERMAN CASUALTY RATES

APPENDIX C

GERMAN DIVISIONS – TBC RATES

Attack Sectors Only, 12 Major Campaigns – Eastern Front, 1942-1945

(Average TBC/1000/Day for Stated Duration)

Attack sector	Duration (days)															
	1 – 5 Days				6 – 10 Days				11 – 15 Days		16 – 20 Days		21 – 30 Days		> 30 Days	
	20.22	(2)	21.33	(3)	12.14	(6)	95.44	(10)f3	10.73	(11)	18.22	(16)	6.85	(21)	3.52	(62)
	282.49	(3)[a,f2]	15.38	(4)	1.75	(6)	69.11	(10)	36.16	(11)[a]	13.19	(16)	11.33	(21)	7.16	(41)
	162.94	(3)[b]	8.91	(4)	116.92	(7)f1	9.95	(10)	12.74	(11)	12.12	(16)	7.02	(22)	.14	(41)
	14.29	(3)	7.04	(4)	47.87	(7)	5.27	(10)	23.57	(12)	11.14	(17)	3.19	(23)		
	13.37	(3)	45.95	(4)	27.77	(7)	13.75	(10)	4.13	(12)	6.96	(17)	1.78	(24)		
	255.92	(3)[b]	41.98	(4)	12.84	(7)	1.01	(10)	5.89	(12)	6.80	(17)	7.27	(28)		
	37.60	(3)	82.52	(4)[b]	3.05	(7)	1.89	(10)	10.57	(12)[a]	7.13	(18)				
Main attack sector	24.4	(3)	41.91	(5)	7.00	(7)	2.50	(10)	9.70	(12)	25.59	(18)				
	14.98	(3)	31.12	(5)	2.58	(7)	1.83	(10)	2.64	(12)	5.10	(18)				
			8.96	(5)	2.31	(7)			15.36	(13)	1.61	(18)				
			6.82	(5)	.73	(7)			2.65	(14)	9.36	(18)				
			4.09	(5)	9.12	(8)			2.41	(14)	4.05	(19)				
					46.86	(8)c			3.31	(14)	3.12	(20)				
					3.30	(8)			3.17	(15)	4.14	(20)				
					3.51	(8)										
					0.17	(8)										
					17.59	(9)[d]										

a "Division" initial strength equates to single regiment (or less).
b "Division" initial strength equates to between 1 and 2 regiments.
c Typical of divisions nearly shattered, then withdrawn in disorder.
d Encircled then breakout.
e1 Retrograde, resisting encirclement
e2 Encircled and destroyed. (Note: e1 and e2 are same division, consecutive time periods)
f1 Division at point of disruption.
f2 Same division, reduced to regiment.
f3 Same division, overall TBC rate over full ten days - division destroyed.

APPENDIX C (CONTINUED)

GERMAN DIVISIONS – TOTAL BATTLE CASUALTY RATES
Attack Sectors Only, 12 Major Campaigns – Eastern Front, 1942-1945
(Average TBC/1000/Day for Stated Duration)

Attack Sector	Duration (Days)						
	1 – 5 Days	6 – 10 Days		11 – 15 Days	16 – 20 Days	21 – 30 Days	> 30 Days
Flank of Main Attack Sector	2.93 (3)	6.28 (7)	3.82 (10)	40.41 (11)[e2]	3.59 (16)		3.44 (31)
	1.98 (3)	3.05 (7)	1.89 (10)	11.96 (13)	4.14 (20)		4.20 (31)
	10.98 (4)	7.00 (7)	2.50 (10)	2.53 (14)			5.65 (32)
	6.59 (4)	18.82 (8)	1.83 (10)	16.44 (14)			
	3.51 (4)	37.71 (8)[e1]					
	15.30 (5)	7.36 (8)					
	19.76 (5)						
Secondary Attack Sector	18.74 (2)	2.04 (6)		10.74 (11)	26.61 (16)	1.76 (21)	4.33 (31)
	73.00 (3)	4.58 (8)		6.34 (11)	22.05 (16)	3.94 (29)	2.95 (31)
	22.55 (3)	5.60 (8)		4.07 (11)	0.98 (16)		3.15 (31)
		4.92 (9)		1.87 (12)	3.53 (17)		4.71 (31)
		2.39 (10)		12.48 (13)	3.91 (17)		0.82 (34)
		3.50 (10)		10.96 (13)	6.34 (18)		
		3.27 (10)		20.58 (14)	3.13 (19)		
		5.55 (10)		7.25 (14)	5.35 (20)		
		40.91 (10)[d]		11.38 (15)	7.00 (20)		
		25.00 (10)		9.38 (15)			
				3.35 (15)			

a "Division" initial strength equates to single regiment (or less).
b "Division" initial strength equates to between 1 and 2 regiments.
c Typical of divisions nearly shattered, then withdrawn in disorder.
d Encircled then breakout.
e1 Retrograde, resisting encirclement
e2 Encircled and destroyed. (Note: e1 and e2 are same division, consecutive time periods)
f1 Division at point of disruption.
f2 Same division, reduced to regiment.
f3 Same division, overall TBC rate over full ten days - division destroyed.

APPENDIX D

U.S. ARMY, KOREA

APPENDIX D

U.S. ARMY, KOREA

These data are extracted from Frank A. Reister's study, *Battle Casualties and Medical Statistics: U.S. Army Experience in the Korean War* (The Surgeon General, Department of the Army, Washington, D.C.). We have extracted data showing divisional and regimental unit perspectives for the same set of 85 operations (plus summary data for longer periods). Rates measure casualties per 1000 personnel per day.

Reister's battle casualties show only killed and wounded. Missing and captured are excluded. [Note: Wounded are divided into "carded-for-record only," or "CRO," and "admissions." CRO cases are those treated quickly and returned to the unit.] Total killed and wounded are labeled "total hit."

Operation names are self-explanatory. We have added a code to each record to indicate the type of operation as identified by Reister. The codes are as follows:

- TOT – Total (summary of all operations)
- DO – Defensive Operations (against early major Communist offensives)
- WO – Withdrawal Operations (during Communist general offensive)
- OO – Offensive Operations (U.S. part of major U.N. offensive)
- PMO – Pursuit and Mopping-up Operations
- ADL – All Defensive Lines (including limited operations)
- DLEL – Defensive Lines Excluding Limited Operations (particular DL)
- DLIL – Defensive Lines Including Limited Operations (particular DL)
- LODL – Limited Operations from Defensive Lines (mostly battles)
- RGR – Redeploying and Regrouping
- RES – Reserve (army or corps)

	Nbr of UNITS Div/Rgt	Nbr of UNIT DAYS	MEAN STRENGTH	TOTAL HIT NUMBER	TOTAL HIT RATE	KILLED IN ACTION NUMBER	KILLED IN ACTION RATE	WOUNDED IN ACTION CRO CASES NUMBER	WOUNDED IN ACTION CRO CASES RATE	WOUNDED IN ACTION ADMISSIONS NUMBER	WOUNDED IN ACTION ADMISSIONS RATE
OPER. NAME:TOTAL (1) DIVs AND SEPARATE REGIMENTAL COMBAT TEAMS (RCTs), or (2) RGTs & RCTs											
OPER. TYPE:TOT								START: 07/04/50		END: 07/27/53	
(1) Div-	8	6522	18305	104048	0.87	18654	0.16	12468	0.10	72926	0.61
(2) Rgt-	28	20568	3457	94086	1.32	16764	0.24	11020	0.15	66302	0.93
OPER. NAME:TOTAL COMBAT OPERATIONS (LESS REDEPLOYING, REGROUPING, & ARMY RESERV											
OPER. TYPE:TOT								START: 07/04/50		END: 07/27/53	
Div-	8	5256	18177	103030	1.08	18498	0.19	12189	0.13	72343	0.76
Rgt-	28	16519	3440	93460	1.64	16664	0.29	10829	0.19	65967	1.16
OPER. NAME:DEFENSIVE OPERATIONS (MAJOR COMMUNIST OFFENSIVE)											
OPER. TYPE:DO								START: 07/04/50		END: 07/20/53	
Div-	7	376	15484	27235	4.67	6881	1.18	1879	0.32	18475	3.17
Rgt-	24	1233	2791	23551	6.84	5902	1.72	1537	0.44	16112	4.68
OPER. NAME:DELAYING INVASION OF SOUTH KOREA											
OPER. TYPE:DO								START: 07/04/50		END: 08/03/50	
Div-	3	69	12043	4579	5.51	1991	2.40	150	0.18	2438	2.93
Rgt-	11	217	2180	3859	8.16	1722	3.64	107	0.23	2030	4.29
OPER. NAME:DEFENSE OF PUSAN PERIMETER											
OPER. TYPE:DO								START: 08/04/50		END: 09/15/50	
Div-	4	168	14345	11431	4.75	2623	1.09	717	0.30	8091	3.36
Rgt-	14	552	2493	9906	7.20	2252	1.64	560	0.40	7094	5.16
OPER. NAME:CCF COUNTEROFFENSIVE IN NORTH KOREA											
OPER. TYPE:DO								START: 11/25/50		END: 12/15/50	
Div-	6	34	16778	3684	6.46	562	0.99	114	0.20	3008	5.27
Rgt-	19	120	3011	3064	8.48	439	1.21	60	0.17	2565	7.10

	Nbr of UNITS Div/Rgt	Nbr of UNIT DAYS	MEAN STRENGTH	TOTAL HIT NUMBER	TOTAL HIT RATE	KILLED IN ACTION NUMBER	KILLED IN ACTION RATE	WOUNDED IN ACTION CRO CASES NUMBER	WOUNDED IN ACTION CRO CASES RATE	WOUNDED IN ACTION ADMISSIONS NUMBER	WOUNDED IN ACTION ADMISSIONS RATE
OPER. NAME:CCF COUNTERATTACK IN WONJU-CHIPYONG AREA											
OPER. TYPE:DO								START: 02/12/51		END: 02/21/51	
Div-	3	24	17220	2109	5.11	651	1.58	162	0.39	1296	3.14
Rgt-	10	82	3113	1652	6.47	498	1.95	110	0.43	1044	4.09
OPER. NAME:CCF FIRST SPRING OFFENSIVE (1951)											
OPER. TYPE:DO								START: 04/22/51		END: 04/29/51	
Div-	5	32	18343	1914	3.25	314	0.53	219	0.37	1381	2.35
Rgt-	15	96	3673	1746	4.95	286	0.81	204	0.58	1256	3.56
OPER. NAME:CCF SECOND SPRING OFFENSIVE											
OPER. TYPE:DO								START: 05/17/51		END: 05/22/51	
Div-	3	15	19520	1221	4.18	333	1.14	116	0.40	772	2.64
Rgt-	9	45	3801	1160	6.78	315	1.84	107	0.63	738	4.31
OPER. NAME:CCF ATTACK ON WESTERN AND CENTRAL FRONTS (1952)											
OPER. TYPE:DO								START: 10/06/52		END: 10/13/52	
Div-	1	8	17395	399	2.88	51	0.37	119	0.86	229	1.65
Rgt-	3	24	3374	369	4.56	49	0.61	115	1.42	205	2.53
OPER. NAME:CCF ATTACK ROK II CORPS FRONT (1953)											
OPER. TYPE:DO								START: 06/10/53		END: 06/18/53	
Div-	1	9	22957	998	4.83	174	0.84	145	0.70	679	3.29
Rgt-	4	36	3644	944	7.19	163	1.24	142	1.08	639	4.87
OPER. NAME:BATTLE OF KUMSONG RIVER, SALIENT											
OPER. TYPE:DO								START: 07/14/53		END: 07/20/53	
Div-	3	17	21860	900	2.42	182	0.49	137	0.37	581	1.56
Rgt-	11	61	3922	851	3.55	178	0.74	132	0.55	541	2.26

	Nbr of UNITS Div/Rgt	Nbr of UNIT DAYS	MEAN STRENGTH	TOTAL HIT NUMBER	TOTAL HIT RATE	KILLED IN ACTION NUMBER	KILLED IN ACTION RATE	WOUNDED CRO CASES NUMBER	WOUNDED CRO CASES RATE	IN ACTION ADMISSIONS NUMBER	IN ACTION ADMISSIONS RATE
OPER. NAME:WITHDRAWAL OPERATIONS (COMMUNIST GENERAL OFFENSIVE)											
OPER. TYPE:DO								START: 12/01/50		END: 01/16/51	
Div-	6	194	15666	1795	0.59	310	0.10	205	0.07	1280	0.42
Rgt-	19	610	2939	1493	0.83	267	0.15	165	0.09	1061	0.59
OPER. NAME:EVACUATION OF HUNGNAM											
OPER. TYPE:WO								START: 12/01/50		END: 12/24/50	
Div-	2	43	15044	638	0.99	117	0.18	13	0.02	508	0.79
Rgt-	6	129	2864	531	1.44	102	0.28	13	0.03	416	1.13
OPER. NAME:WITHDRAWAL FROM NORTH KOREA TO LINE "D"											
OPER. TYPE:WO								START: 12/02/50		END: 01/16/51	
Div-	4	151	15843	1157	0.48	193	0.08	192	0.08	772	0.32
Rgt-	13	481	2959	962	0.68	165	0.12	152	0.11	645	0.45
OPER. NAME:OFFENSIVE OPERATIONS (MAJOR UN OFFENSIVES)											
OPER. TYPE:OO								START: 09/16/50		END: 10/22/51	
Div-	6	632	17164	25737	2.37	3943	0.36	2279	0.21	19515	1.80
Rgt-	19	1924	3319	23884	3.74	3641	0.57	2017	0.32	18226	2.85
OPER. NAME:BREAKOUT OF PUSAN PERIMETER											
OPER. TYPE:OO								START: 09/16/50		END: 09/27/50	
Div-	4	48	15217	4334	5.94	790	1.08	340	0.47	3204	4.39
Rgt-	12	144	2816	3896	9.61	692	1.71	276	0.68	2928	7.22
OPER. NAME:INCHON LANDING AND LIBERATION OF SEOUL											
OPER. TYPE:OO								START: 09/18/50		END: 09/30/50	
Div-	1	13	14127	418	2.28	94	0.51	5	0.03	319	1.74
Rgt-	4	39	3109	381	3.14	86	0.71	3	0.02	292	2.41

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Div/Rgt											
OPER. NAME:OPERATION THUNDERBOLT-ARMED RECON TO RETAKE OFFENSIVE											
OPER. TYPE:00								START: 01/25/51		END: 02/20/51	
Div-	6	125	16495	3788	1.84	667	0.32	218	0.11	2903	1.41
Rgt-	19	384	3189	3551	2.90	624	0.51	199	0.16	2728	2.23
OPER. NAME:OPERATION KILLER-TO REESTABLISH UN LINE EAST OF WONJU											
OPER. TYPE:00								START: 02/21/51		END: 03/07/51	
Div-	4	56	16135	1065	1.18	144	0.16	117	0.13	804	0.89
Rgt-	12	168	3114	1000	1.91	137	0.26	107	0.20	756	1.45
OPER. NAME:OPERATION RIPPER-TO OUTFLANK SEOUL AND CAPTURE CHUNCHON											
OPER. TYPE:00								START: 03/07/51		END: 04/04/51	
Div-	6	161	16562	3786	1.41	566	0.21	329	0.12	2891	1.08
Rgt-	19	490	3214	3503	2.22	528	0.33	292	0.19	2683	1.70
OPER. NAME:OPERATION RUGGED-TO SECURE PHASE LINE KANSAS NORTH OF 38TH PARALLEL											
OPER. TYPE:00								START: 04/01/51		END: 04/15/51	
Div-	6	44	17278	1057	1.40	156	0.21	136	0.18	765	1.01
Rgt-	18	132	3403	921	2.05	137	0.30	116	0.26	668	1.49
OPER. NAME:OPERATION DAUNTLESS-TO SECURE PHASE LINE UTAH FORWARD TO LINE KANSAS											
OPER. TYPE:00								START: 04/10/51		END: 04/22/51	
Div-	3	36	18479	1151	1.73	95	0.14	73	0.11	983	1.48
Rgt-	9	108	3706	1072	2.68	87	0.22	64	0.16	921	2.30
OPER. NAME:OPERATION DETONATE-RETURN TO 38TH PARALLEL THIRD TIME,RETAKE KANSAS											
OPER. TYPE:00								START: 05/20/51		END: 06/08/51	
Div-	6	88	19201	3725	2.20	530	0.31	376	0.22	2819	1.67
Rgt-	19	276	3644	3430	3.41	494	0.49	328	0.33	2608	2.59

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OPER. NAME:OPERATION PILEDRIVER-TO SECURE PHASE LINE WYOMING & IRON TRIANGLE											
OPER. TYPE:OO								START: 06/03/51		END: 06/12/51	
Div-	4	35	18622	2018	3.09	231	0.35	379	0.58	1408	2.16
Rgt-	12	105	3625	1929	5.07	224	0.59	369	0.97	1336	3.51
OPER. NAME:OPERATION COMMANDO-TO SECURE PHASE LINE JAMESTOWN											
OPER. TYPE:OO								START: 10/03/51		END: 10/15/51	
Div-	2	16	19942	2643	8.28	405	1.27	230	0.72	2008	6.29
Rgt-	6	48	3856	2509	13.55	382	2.06	195	1.05	1932	10.44
OPER. NAME:OPERATION NOMAD & POLAR-SECURE PHASE LINES DESIGNATED AS MISSOURI											
OPER. TYPE:OO								START: 10/13/51		END: 10/22/51	
Div-	1	10	21585	1752	8.12	265	1.23	76	0.35	1411	6.54
Rgt-	3	30	3864	1692	14.60	250	2.16	68	0.59	1374	11.85
OPER. NAME:PURSUIT AND MOPPING UP OPERATIONS											
OPER. TYPE:PMO								START: 09/28/50		END: 11/30/50	
Div-	6	303	16028	3594	0.73	702	0.14	263	0.05	2629	0.54
Rgt-	19	975	2965	2999	1.04	589	0.20	188	0.07	2222	0.77
OPER. NAME:PURSUIT AND MOPPING UP SOUTH OF 38TH PARALLEL											
OPER. TYPE:PMO								START: 09/28/50		END: 11/30/50	
Div-	5	113	16946	832	0.44	194	0.10	129	0.07	509	0.27
Rgt-	16	399	2860	627	0.55	153	0.13	103	0.09	371	0.33
OPER. NAME:PURSUIT NORTH OF 38 PARALLEL TO YALU RIVER											
OPER. TYPE:PMO								START: 10/05/50		END: 11/27/50	
Div-	5	162	15601	2533	1.00	463	0.18	129	0.05	1941	0.77
Rgt-	16	500	3066	2171	1.41	400	0.26	80	0.05	1691	1.10

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OPER. NAME:IWON LANDING AND PURSUIT NORTH OF 38TH PARALLEL											
OPER. TYPE:PMO								START: 10/31/50		END: 11/27/50	
Div-	1	28	14788	229	0.55	45	0.11	5	0.01	179	0.43
Rgt-	3	76	2849	201	0.93	36	0.17	5	0.02	160	0.74
OPER. NAME:ALL DEFENSIVE LINES (INCLUDING LIMITED OPERATIONS)											
OPER. TYPE:ADL								START: 01/05/51		END: 07/27/53	
Div-	8	3751	18921	44669	0.63	6662	0.09	7563	0.11	30444	0.43
Rgt-	26	11777	3593	41533	0.98	6265	0.15	6922	0.16	28346	0.67
OPER. NAME:DEFENSIVE LINES(EXCLUDING LIMITED OPERATIONS)											
OPER. TYPE:DLEL								START: 01/05/51		END: 07/27/53	
Div-	8	3494	18926	26727	0.40	3629	0.05	5549	0.08	17549	0.27
Rgt-	26	10996	3558	24453	0.62	3364	0.08	5059	0.13	16030	0.41
OPER. NAME:LINE "D" (FURTHEST CCF PENETRATION INTO SOUTH KOREA 1951)											
OPER. TYPE:DLEL								START: 01/05/51		END: 01/29/51	
Div-	6	107	16548	372	0.21	93	0.05	13	0.01	266	0.15
Rgt-	19	342	3120	324	0.30	85	0.08	10	0.01	229	0.21
OPER. NAME:LINE BOSTON (SOUTH BANK-HAN RIVER; SOUTHEAST OF SEOUL, I CORPS SECT											
OPER. TYPE:DLEL								START: 02/18/51		END: 03/06/51	
Div-	2	32	16194	147	0.28	22	0.04	26	0.05	99	0.19
Rgt-	6	96	3143	135	0.45	20	0.07	25	0.08	90	0.30
OPER. NAME:LINE KANSAS (8TH ARMY PHASE LINE ACROSS KOREA; NORTH/SOUTH OF 38TH P											
OPER. TYPE:DLEL								START: 04/04/51		END: 04/29/51	
Div-	6	48	17847	303	0.35	46	0.05	74	0.09	183	0.21
Rgt-	18	144	3563	235	0.46	35	0.07	65	0.13	135	0.26

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OPER. NAME:LINE GOLDEN (I CORPS DEFENSIVE LINE NORTH OF SEOUL, HALTING CCF OFF											
OPER. TYPE:DLEL								START: 04/29/51		END: 05/19/51	
Div-	3	58	19323	438	0.39	33	0.03	151	0.13	254	0.23
Rgt-	9	174	3824	379	0.57	31	0.05	140	0.21	208	0.31
OPER. NAME:LINE NO NAME(8TH ARMY DEFENSIVE LINE IN IX/X CORPS,HALTING SPR OFF											
OPER. TYPE:DLEL								START: 04/29/51		END: 05/19/51	
Div-	3	55	18486	223	0.23	27	0.03	18	0.02	178	0.18
Rgt-	9	165	3715	175	0.29	23	0.04	17	0.03	135	0.22
OPER. NAME:LINE WYOMING-I CORPS(PHASE LINE FORWARD OF LINE KANSAS, AROUND 38TH PARALLE											
OPER. TYPE:DLEL								START: 06/10/51		END: 10/02/51	
Div-	3	219	18859	1987	0.48	280	0.07	583	0.14	1124	0.27
Rgt-	9	657	3643	1751	0.73	250	0.10	515	0.22	986	0.41
OPER. NAME:LINE WYOMING-IX CORPS (PHASE LINE FORWARD OF LINE KANSAS, ABOVE 38 PARALLE											
OPER. TYPE:DLEL								START: 06/13/51		END: 10/31/51	
Div-	3	200	20657	2324	0.56	344	0.08	336	0.08	1644	0.40
Rgt-	11	648	3729	2169	0.90	332	0.14	308	0.13	1529	0.63
OPER. NAME:LINE KANSAS/HAYS-X CORPS(PHASE LINE ABOVE 38 PARALLEL, X CORPS SECT											
OPER. TYPE:DLEL								START: 07/15/51		END: 10/04/51	
Div-	1	46	18504	649	0.76	90	0.11	123	0.14	436	0.51
Rgt-	3	138	3479	589	1.23	84	0.17	113	0.24	392	0.82
OPER. NAME:LINE JAMESTOWN(MAIN BATTLE POSITION I CORPS SECTOR ON WESTERN FRONT											
OPER. TYPE:DLEL								START: 10/07/51		END: 07/27/53	
Div-	6	957	17971	7287	0.42	1042	0.06	1594	0.09	4651	0.27
Rgt-	18	2814	3614	6727	0.65	958	0.09	1455	0.14	4314	0.42

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OPER. NAME:LINE MISSOURI(MAIN BATTLE POSITION IX CORPS SECTOR ON CENTRAL FRONT											
OPER. TYPE:DLEL								START: 10/23/51		END: 07/27/53	
Div-	6	940	19208	6007	0.33	761	0.04	1246	0.07	4000	0.22
Rgt-	19	2970	3656	5563	0.52	716	0.07	1171	0.11	3676	0.34
OPER. NAME:LINE MINNESOTA(MAIN BATTLE POSITION X CORPS SECTOR ON EASTERN FRONT											
OPER. TYPE:DLEL								START: 10/16/51		END: 07/27/53	
Div-	5	832	19808	6990	0.42	891	0.05	1385	0.08	4714	0.29
Rgt-	16	2848	3523	6406	0.64	830	0.08	1240	0.12	4336	0.44
OPER. NAME:DEFENSIVE LINES (INCLUDING LIMITED OPERATIONS)											
OPER. TYPE:DLIL								START: 06/10/51		END: 07/27/53	
Div-	8	3451	19035	43186	0.66	6441	0.10	7281	0.11	29464	0.45
Rgt-	26	10856	3607	40285	1.03	6071	0.16	6665	0.17	27549	0.70
OPER. NAME:LINE WYOMING-I CORPS											
OPER. TYPE:DLIL								START: 06/10/51		END: 10/03/51	
Div-	3	239	18894	3121	0.69	446	0.10	775	0.17	1900	0.42
Rgt-	9	717	3650	2840	1.09	411	0.16	696	0.27	1733	0.66
OPER. NAME:LINE WYOMING-IX CORPS											
OPER. TYPE:DLIL								START: 06/13/51		END: 10/31/51	
Div-	3	221	20667	4110	0.89	627	0.14	522	0.11	2961	0.64
Rgt-	11	717	3722	3888	1.46	604	0.23	493	0.18	2791	1.05
OPER. NAME:LINE KANSAS/HAYS-X CORPS											
OPER. TYPE:DLIL								START: 07/15/51		END: 10/15/51	
Div-	1	93	18980	5958	3.38	984	0.56	498	0.28	4476	2.54
Rgt-	3	279	3545	5655	5.72	948	0.96	433	0.44	4274	4.32

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OPER. NAME:LINE JAMESTOWN											
OPER. TYPE:DLIL								START: 10/07/51		END: 07/27/53	
Div-	6	1077	18024	14354	0.74	2284	0.12	2420	0.12	9650	0.50
Rgt-	18	3174	3613	13383	1.17	2135	0.19	2210	0.19	9038	0.79
OPER. NAME:LINE MISSOURI											
OPER. TYPE:DLIL								START: 10/23/51		END: 07/27/53	
Div-	6	979	19143	8346	0.45	1152	0.06	1632	0.09	5562	0.30
Rgt-	19	3087	3645	7813	0.69	1089	0.09	1544	0.14	5180	0.46
OPER. NAME:LINE MINNESOTA											
OPER. TYPE:DLIL								START: 10/16/51		END: 07/27/53	
Div-	5	842	19820	7297	0.44	948	0.06	1434	0.09	4915	0.29
Rgt-	16	2882	3526	6706	0.66	884	0.08	1289	0.13	4533	0.45
OPER. NAME:LIMITED OPERATIONS FROM DEFENSIVE LINES											
OPER. TYPE:LODL								START: 06/26/51		END: 07/24/53	
Div-	8	257	18847	17942	3.71	3033	0.63	2014	0.42	12895	2.66
Rgt-	25	781	3590	17080	6.08	2901	1.03	1863	0.66	12316	4.39
OPER. NAME:OPERATIONS FROM LINE WYOMING											
OPER. TYPE:LODL								START: 06/26/51		END: 10/03/51	
Div-	5	41	20039	2920	3.56	449	0.55	378	0.46	2093	2.55
Rgt-	15	129	3835	2808	5.90	433	0.91	366	0.77	2009	4.22
OPER. NAME:LINE WYOMING-I CORPS											
OPER. TYPE:LODL								START: 07/01/51		END: 10/03/51	
Div-	2	20	19280	1134	2.94	166	0.43	192	0.50	776	2.01
Rgt-	6	60	3729	1089	4.87	161	0.72	181	0.81	747	3.34

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OPER. NAME:OPERATION DOUGHNUT-TO SEIZE DOMINATING TERRAIN OF SOBANG MOUNTAINS											
OPER. TYPE:LODL								START: 07/01/51		END: 07/04/51	
Div-	1	4	18618	219	2.94	25	0.34	41	0.55	153	2.05
Rgt-	3	12	3492	217	5.18	25	0.60	40	0.95	152	3.63
OPER. NAME:RAID ON DIG AND KWIJON-NI											
OPER. TYPE:LODL								START: 08/03/51		END: 08/08/51	
Div-	1	6	18367	175	1.58	20	0.18	51	0.46	104	0.94
Rgt-	3	18	3648	159	2.42	20	0.30	44	0.67	95	1.45
OPER. NAME:ATTACK ON HILLS 272 AND 487											
OPER. TYPE:LODL								START: 08/18/51		END: 08/19/51	
Div-	1	2	18367	78	2.12	14	0.38	14	0.38	50	1.36
Rgt-	3	6	3648	72	3.29	14	0.64	13	0.59	45	2.06
OPER. NAME:OPERATION CITADEL-TO MOVE MLR FORWARD TO OPLR											
OPER. TYPE:LODL								START: 09/09/51		END: 09/10/51	
Div-	1	2	19685	35	0.89	0	0.00	13	0.33	22	0.56
Rgt-	3	6	3766	34	1.50	-99	-99.00	13	0.57	21	0.93
OPER. NAME:OPERATION CLEAN-UP -ATTEMPT TO SWEEP ENEMY FROM FRONT OF POSITION											
OPER. TYPE:LODL								START: 09/18/51		END: 09/18/51	
Div-	1	1	20443	111	5.43	18	0.88	11	0.54	82	4.01
Rgt-	3	3	3870	107	9.21	17	1.46	11	0.95	79	6.80
OPER. NAME:OPERATION CLEAN-UP II-TO SECURE RAILROAD RUNNING NORTH FROM UIJONGBU											
OPER. TYPE:LODL								START: 09/29/51		END: 10/03/51	
Div-	1	5	20874	516	4.94	89	0.85	62	0.59	365	3.50
Rgt-	3	15	4004	500	8.33	85	1.42	60	1.00	355	5.91

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OPER. NAME:LINE WYOMING - IX CORPS											
OPER. TYPE:LODL								START: 06/26/51		END: 09/21/51	
Div-	3	21	20762	1786	4.10	283	0.65	186	0.43	1317	3.02
Rgt-	10	69	3935	1719	6.82	272	1.08	185	0.73	1262	5.01
OPER. NAME:OPERATION CAT AND DOG-TO DESTROY ENEMY POSITIONS AND CAPTURE PRISONERS											
OPER. TYPE:LODL								START: 06/26/51		END: 06/28/51	
Div-	1	3	19617	293	4.98	32	0.54	48	0.82	213	3.62
Rgt-	3	9	3393	288	9.43	32	1.05	48	1.57	208	6.81
OPER. NAME:ATTACK ON HILLS 682 AND 850											
OPER. TYPE:LODL								START: 07/12/51		END: 07/15/51	
Div-	1	4	19412	213	2.75	37	0.48	16	0.21	160	2.06
Rgt-	3	12	3496	207	4.93	36	0.85	16	0.38	155	3.70
OPER. NAME:OPERATION COW PUNCHER-TO SECURE PHASE LINE UTAH FORWARD OF LINE WYOMING											
OPER. TYPE:LODL								START: 08/02/51		END: 08/03/51	
Div-	1	2	18765	50	1.33	8	0.21	3	0.08	39	1.04
Rgt-	3	6	3495	49	2.33	8	0.38	3	0.14	38	1.81
OPER. NAME:ATTACK ON HILLS 658 AND 851											
OPER. TYPE:LODL								START: 08/31/51		END: 09/04/51	
Div-	1	5	19716	616	6.25	120	1.22	52	0.53	444	4.50
Rgt-	3	15	3850	604	10.46	117	2.03	52	0.90	435	7.53
OPER. NAME:OPERATION OHIO-SLOAN-TO SECURE NEW POSITIONS ON LINE WYOMING											
OPER. TYPE:LODL								START: 09/08/51		END: 09/12/51	
Div-	1	5	23679	502	4.24	68	0.57	53	0.45	381	3.22
Rgt-	4	20	3678	485	6.59	66	0.90	52	0.70	367	4.99

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OPER.	NAME:OPERATION CLEAVER-TANK/INFANTRY RAID IN THE IRON TRIANGLE										
OPER.	TYPE:LODL							START: 09/21/51		END: 09/21/51	
Div-	2	2	22503	112	2.49	18	0.40	14	0.31	80	1.78
Rgt-	7	7	3870	86	3.17	13	0.47	14	0.52	59	2.18
OPER.	NAME:OPERATIONS FROM LINE KANSAS/HAYS-X CORPS										
OPER.	TYPE:LODL							START: 07/26/51		END: 10/15/51	
Div-	1	47	19445	5309	5.81	894	0.98	375	0.41	4040	4.42
Rgt-	3	141	3609	5066	9.96	864	1.70	320	0.63	3882	7.63
OPER.	NAME:LINE KANSAS										
OPER.	TYPE:LODL							START: 07/26/51		END: 09/05/51	
Div-	1	15	18889	1839	6.49	316	1.12	154	0.54	1369	4.83
Rgt-	3	45	3602	1781	10.99	311	1.92	133	0.82	1337	8.25
OPER.	NAME:ATTACK ON HILLS 1059, 1100, 1120, AND 1179										
OPER.	TYPE:LODL							START: 07/26/51		END: 07/30/51	
Div-	1	5	17290	373	4.32	44	0.51	36	0.42	293	3.39
Rgt-	3	15	3259	360	7.36	43	0.88	33	0.67	284	5.81
OPER.	NAME:BATTLE OF BLOODY RIDGE (RIDGE FROM HILL 900 TO 983)										
OPER.	TYPE:LODL							START: 08/27/51		END: 09/05/51	
Div-	1	10	19689	1466	7.45	272	1.38	118	0.60	1076	5.47
Rgt-	3	30	3774	1421	12.55	268	2.37	100	0.88	1053	9.30
OPER.	NAME:LINE HAYS										
OPER.	TYPE:LODL							START: 09/09/51		END: 10/15/51	
Div-	1	32	19706	3470	5.51	578	0.92	221	0.35	2671	4.24
Rgt-	3	96	3612	3285	9.47	553	1.59	187	0.54	2545	7.34

	Nbr of UNITS Div/Rgt	Nbr of UNIT DAYS	MEAN STRENGTH	TOTAL HIT NUMBER	TOTAL HIT RATE	KILLED IN ACTION NUMBER	KILLED IN ACTION RATE	WOUNDED IN ACTION CRO CASES NUMBER	WOUNDED IN ACTION CRO CASES RATE	WOUNDED IN ACTION ADMISSIONS NUMBER	WOUNDED IN ACTION ADMISSIONS RATE
OPER. NAME:ATTACK ON HILL 868											
OPER. TYPE:LODL								START: 09/09/51		END: 09/12/51	
Div-	1	4	19903	327	4.10	48	0.60	25	0.31	254	3.19
Rgt-	3	12	3793	318	6.98	48	1.05	21	0.46	249	5.47
OPER. NAME:FIRST BATTLE OF HEARTBREAK RIDGE											
OPER. TYPE:LODL								START: 09/13/51		END: 09/29/51	
Div-	1	17	19697	1607	4.80	314	0.94	108	0.32	1185	3.54
Rgt-	3	51	3643	1522	8.19	301	1.62	93	0.50	1128	6.07
OPER. NAME:SECOND BATTLE OF HEARTBREAK RIDGE											
OPER. TYPE:LODL								START: 10/05/51		END: 10/06/51	
Div-	1	2	19647	264	6.72	33	0.84	24	0.61	207	5.27
Rgt-	3	6	3499	244	11.62	30	1.43	19	0.90	195	9.29
OPER. NAME:ATTACK ON HILLS 851, 1220, AND ADJACENT RIDGES											
OPER. TYPE:LODL								START: 10/07/51		END: 10/15/51	
Div-	1	9	19647	1272	7.19	183	1.03	64	0.36	1025	5.80
Rgt-	3	27	3499	1201	12.71	174	1.84	54	0.57	973	10.30
OPER. NAME:OPERATIONS FROM LINES JAMESTOWN, MISSOURI, AND MINNESOTA											
OPER. TYPE:LODL								START: 10/16/51		END: 07/24/53	
Div-	7	169	18391	9713	3.13	1690	0.54	1261	0.41	6762	2.18
Rgt-	22	511	3560	9206	5.06	1604	0.88	1177	0.65	6425	3.53
OPER. NAME:LINE JAMESTOWN-I CORPS											
OPER. TYPE:LODL								START: 10/16/51		END: 07/24/53	
Div-	6	120	18452	7067	3.19	1242	0.56	826	0.37	4999	2.26
Rgt-	18	360	3603	6656	5.13	1177	0.91	755	0.58	4724	3.64

	Nbr of UNITS Div/Rgt	Nbr of UNIT DAYS	MEAN STRENGTH	TOTAL HIT NUMBER	TOTAL HIT RATE	KILLED IN ACTION NUMBER	KILLED IN ACTION RATE	WOUNDED IN ACTION CRO CASES NUMBER	WOUNDED IN ACTION CRO CASES RATE	WOUNDED IN ACTION ADMISSIONS NUMBER	WOUNDED IN ACTION ADMISSIONS RATE
OPER. NAME:OPERATION POLECHARGE-TO SECURE THREE HILL MASSES ON LINE											
OPER. TYPE:LODL								START: 10/16/51		END: 10/18/51	
Div-	1	3	19727	460	7.77	72	1.22	34	0.57	354	5.98
Rgt-	3	9	3822	416	12.09	65	1.89	16	0.46	335	9.74
OPER. NAME:ATTACK ON HILL 199											
OPER. TYPE:LODL								START: 10/24/51		END: 10/30/51	
Div-	1	7	19727	853	6.17	105	0.76	209	1.51	539	3.90
Rgt-	3	21	3822	831	10.35	99	1.23	206	2.57	526	6.55
OPER. NAME:DEFENSE OF HILL 200											
OPER. TYPE:LODL								START: 11/05/51		END: 11/10/51	
Div-	1	6	19414	450	3.86	68	0.58	87	0.75	295	2.53
Rgt-	3	18	3914	433	6.15	68	0.97	86	1.22	279	3.96
OPER. NAME:FIRST BATTLE OF PORKCHOP HILL											
OPER. TYPE:LODL								START: 11/22/51		END: 11/25/51	
Div-	1	4	19013	324	4.26	83	1.09	12	0.16	229	3.01
Rgt-	3	12	3670	319	7.24	83	1.88	12	0.27	224	5.09
OPER. NAME:OPERATION CLAM-UP - CEASE ACTIVITY TO LURE ENEMY PATROLS											
OPER. TYPE:LODL								START: 02/10/52		END: 02/16/52	
Div-	2	14	19174	36	0.13	8	0.03	3	0.01	25	0.09
Rgt-	6	42	3850	30	0.19	6	0.04	3	0.02	21	0.13
OPER. NAME:OPERATION COUNTER-TO SECURE ELEVEN KEY TERRAIN FEATURES ON OUTPOST LINE											
OPER. TYPE:LODL								START: 06/07/52		END: 06/25/52	
Div-	1	19	17993	1026	3.00	192	0.56	21	0.06	813	2.38
Rgt-	3	57	3531	970	4.81	188	0.93	13	0.06	769	3.82

	Nbr of UNITS Div/Rgt	Nbr of UNIT DAYS	MEAN STRENGTH	TOTAL HIT NUMBER	TOTAL HIT RATE	KILLED IN ACTION NUMBER	KILLED IN ACTION RATE	WOUNDED IN ACTION CRO CASES NUMBER	WOUNDED IN ACTION CRO CASES RATE	WOUNDED IN ACTION ADMISSIONS NUMBER	WOUNDED IN ACTION ADMISSIONS RATE
OPER. NAME:FIRST BATTLE OF OLD BALDY											
OPER. TYPE:LODL								START: 06/26/52		END: 07/17/52	
Div-	1	22	18041	408	1.03	90	0.23	12	0.03	306	0.77
Rgt-	3	66	3451	395	1.73	86	0.38	12	0.05	297	1.30
OPER. NAME:SECOND BATTLE OF OLD BALDY											
OPER. TYPE:LODL								START: 07/17/52		END: 07/22/52	
Div-	1	6	17769	387	3.62	73	0.68	46	0.43	268	2.51
Rgt-	3	18	3602	362	5.58	70	1.08	38	0.58	254	3.92
OPER. NAME:THIRD BATTLE OF OLD BALDY											
OPER. TYPE:LODL								START: 08/01/52		END: 08/04/52	
Div-	1	4	17900	119	1.67	18	0.25	24	0.34	77	1.08
Rgt-	3	12	3454	111	2.67	18	0.43	24	0.58	69	1.66
OPER. NAME:FOURTH BATTLE OF OLD BALDY											
OPER. TYPE:LODL								START: 09/18/52		END: 09/21/52	
Div-	1	4	17596	352	5.00	85	1.21	24	0.34	243	3.45
Rgt-	3	12	3394	347	8.52	84	2.06	24	0.59	239	5.87
OPER. NAME:DEFENSE OF OUTPOST KELLY											
OPER. TYPE:LODL								START: 09/18/52		END: 09/30/52	
Div-	1	13	17687	417	1.82	57	0.25	73	0.32	287	1.25
Rgt-	3	39	3285	396	3.09	53	0.41	69	0.54	274	2.14
OPER. NAME:FIFTH BATTLE OF OLD BALDY											
OPER. TYPE:LODL								START: 03/23/53		END: 03/26/53	
Div-	1	4	16064	309	4.81	76	1.18	34	0.53	199	3.10
Rgt-	3	12	3130	285	7.58	74	1.97	32	0.85	179	4.76

	Nbr of UNITS Div/Rgt	Nbr of UNIT DAYS	MEAN STRENGTH	TOTAL HIT NUMBER	TOTAL HIT RATE	KILLED IN ACTION NUMBER	KILLED IN ACTION RATE	WOUNDED IN ACTION CRO CASES NUMBER	WOUNDED IN ACTION CRO CASES RATE	WOUNDED IN ACTION ADMISSIONS NUMBER	WOUNDED IN ACTION ADMISSIONS RATE
OPER. NAME:THIRD BATTLE OF PORKCHOP HILL											
OPER. TYPE:LODL								START: 04/16/53		END: 04/18/53	
Div-	1	3	16638	464	9.29	102	2.04	17	0.34	345	6.91
Rgt-	3	9	3188	430	14.98	93	3.24	17	0.59	320	11.15
OPER. NAME:DEFENSE OF OUTPOST CARSON, ELKO, AND VEGAS											
OPER. TYPE:LODL								START: 05/28/53		END: 05/30/53	
Div-	1	3	21622	133	2.05	17	0.26	35	0.54	81	1.25
Rgt-	3	9	4628	127	3.05	17	0.41	35	0.84	75	1.80
OPER. NAME:FOURTH BATTLE OF PORKCHOP HILL											
OPER. TYPE:LODL								START: 07/06/53		END: 07/11/53	
Div-	1	6	19964	1231	10.28	166	1.39	185	1.54	880	7.35
Rgt-	3	18	3926	1109	15.69	143	2.02	158	2.24	808	11.43
OPER. NAME:DEFENSE OF OUTPOST DALE AND WESTVIEW											
OPER. TYPE:LODL								START: 07/23/53		END: 07/24/53	
Div-	1	2	19964	98	2.45	30	0.75	10	0.25	58	1.45
Rgt-	3	6	3926	95	4.03	30	1.27	10	0.42	55	2.34
OPER. NAME:LINE MISSOURI-IX CORPS											
OPER. TYPE:LODL								START: 02/10/52		END: 11/04/52	
Div-	4	39	17571	2339	3.41	391	0.57	386	0.56	1562	2.28
Rgt-	12	117	3380	2250	5.68	373	0.94	373	0.94	1504	3.80
OPER. NAME:OPERATION CLAM-UP - CEASE ACTIVITY TO LURE ENEMY PATROLS											
OPER. TYPE:LODL								START: 02/10/52		END: 02/15/52	
Div-	2	12	18123	24	0.11	1	0.00	6	0.03	17	0.08
Rgt-	6	36	3547	19	0.15	1	0.01	4	0.03	14	0.11

	Nbr of UNITS Div/Rgt	Nbr of UNIT DAYS	MEAN STRENGTH	TOTAL HIT NUMBER	TOTAL HIT RATE	KILLED IN ACTION NUMBER	KILLED IN ACTION RATE	WOUNDED IN ACTION CRO CASES NUMBER	WOUNDED IN ACTION CRO CASES RATE	WOUNDED IN ACTION ADMISSIONS NUMBER	WOUNDED IN ACTION ADMISSIONS RATE
OPER. NAME:OPERATION SHOWDOWN-TO SECURE HILL 598											
OPER. TYPE:LODL								START: 10/14/52		END: 10/27/52	
Div-	1	14	17395	1806	7.41	305	1.25	346	1.42	1155	4.74
Rgt-	3	42	3374	1744	12.31	292	2.06	336	2.37	1116	7.88
OPER. NAME:DEFENSE OF HILL 391											
OPER. TYPE:LODL								START: 10/24/52		END: 10/28/52	
Div-	1	5	17460	113	1.29	17	0.19	14	0.16	82	0.94
Rgt-	3	15	3182	111	2.33	16	0.34	14	0.29	81	1.70
OPER. NAME:DEFENSE OF OUTPOST CHARLIE AND KING											
OPER. TYPE:LODL								START: 10/28/52		END: 11/04/52	
Div-	1	8	17121	396	2.90	68	0.50	20	0.15	308	2.25
Rgt-	3	24	3264	376	4.80	64	0.82	19	0.24	293	3.74
OPER. NAME:LINE MINNESOTA											
OPER. TYPE:LODL								START: 02/10/52		END: 11/04/52	
Div-	3	10	20851	307	1.47	57	0.27	49	0.24	201	0.96
Rgt-	10	34	3724	300	2.37	54	0.43	49	0.38	197	1.56
OPER. NAME:OPERATION CLAM-UP - CEASE ACTIVITY TO LURE ENEMY PATROLS											
OPER. TYPE:LODL								START: 02/10/52		END: 02/15/52	
Div-	1	6	19636	43	0.36	5	0.04	4	0.03	34	0.29
Rgt-	3	18	3892	43	0.61	5	0.07	4	0.05	34	0.49
OPER. NAME:DEFENSE OF HEARTBREAK RIDGE AREA											
OPER. TYPE:LODL								START: 09/06/52		END: 09/07/52	
Div-	1	2	22272	158	3.54	30	0.67	30	0.67	98	2.20
Rgt-	4	8	3639	155	5.32	29	0.99	30	1.03	96	3.30

	Nbr of UNITS Div/Rgt	Nbr of UNIT DAYS	MEAN STRENGTH	TOTAL HIT NUMBER	TOTAL HIT RATE	KILLED IN ACTION NUMBER	KILLED IN ACTION RATE	WOUNDED IN ACTION CRO CASES NUMBER	WOUNDED IN ACTION CRO CASES RATE	WOUNDED IN ACTION ADMISSIONS NUMBER	WOUNDED IN ACTION ADMISSIONS RATE
OPER. NAME:DEFENSE OF HEARTBREAK RIDGE AREA											
OPER. TYPE:LODL								START: 11/03/52		END: 11/04/52	
Div-	1	2	23073	106	2.31	22	0.48	15	0.33	69	1.50
Rgt-	4	8	3431	102	3.72	20	0.73	15	0.55	67	2.44
OPER. NAME:REDEPLOYING AND REGROUPING											
OPER. TYPE:RGR								START: 12/21/50		END: 01/10/51	
Div-	2	32	15397	62	0.13	26	0.05	3	0.01	33	0.07
Rgt-	6	96	2883	39	0.14	16	0.06	1	0.00	22	0.08
OPER. NAME:CORPS OR ARMY RESERVE											
OPER. TYPE:RES								START: 07/04/50		END: 07/27/53	
Div-	8	1234	18925	956	0.04	130	0.01	276	0.01	550	0.02
Rgt-	25	3953	3542	587	0.04	84	0.01	190	0.01	313	0.02

APPENDIX E

MIDDLE EAST

APPENDIX E

MIDDLE EAST DATABASE

These data are extracted from Trevor N. Dupuy's "Land Warfare Database." They are based largely on interviews. Casualties include killed, wounded, and missing. Strength is the number of personnel at risk at the start of the cited battle. Rates measure casualties per 1000 personnel per day.

YEAR / DURATION	BATTLE / ATTACKER STRENGTH	CAS.	DEFENDER STRENGTH	CAS.	TBC/1000/DAY ATKR RATE	DFDR RATE
1967	Jenin					
	Is Peled Armd Div (-)		Jor 25th Inf Bde			
1	10900	225	6160	200	20.64	32.47
1967	Jerusalem					
	Is Gur Para Bde (+)		Jor 27th Inf Bde (Jerusalem Bde) (+)			
3	27682	1750	13600	1500	21.07	36.76
1967	Kabatiya					
	Is Bar Kochva's Armd Bde (+)		Jor 40th Armd Bde (-) (+)			
2	12800	375	9900	350	14.65	17.68
1967	Tilfit-Zababida					
	Is Ram Armd Bde		Jor 40th Armd Bde (-) (+)			
1	5350	250	5450	250	46.73	45.87
1967	Nablus					
	Is Peled Armd Div		Jor 25th Inf Bde (-) (+)			
1	10700	375	8640	350	35.05	40.51
1967	Rafah					
	Is Tal Div		Eg 7th Inf Div (+)			
1	19520	700	19500	2700	35.86	138.46
1967	Bir Lahfan					
	Is Yoffe Div		Eg 3d Inf Div			
1	10450	90	10050	1350	8.61	134.33
1967	Abu Ageila-Um Katef					
	Is Sharon Div		Eg 2d Inf Div			
1	19280	300	18450	900	15.56	48.78
1967	El Arish					
	Is Tal Div (-)		Eg 7th Inf Div (-)			
1	6912	135	12750	225	19.53	17.65
1967	Jebel Libni					
	Is Yoffe Div (-) (+)		Eg 3d Inf Div (-)			
1	10800	70	3000	450	6.48	150.00
1967	Gaza Strip					
	Is Reshef Task Force		Pales 20th PLA Div (+)			
3	12150	55	17450	626	1.51	11.96
1967	Bir Hassna-Bir Thamada					
	Is Yoffe Div		Eg 3d Inf Div			
1	8700	60	3000	550	6.90	183.33

YEAR / DURATION	BATTLE / ATTACKER STRENGTH	CAS.	DEFENDER STRENGTH	CAS.	TBC/1000/DAY ATKR RATE	DFDR RATE
1967	Mitla Pass					
	Eg 3d Inf Div (+)		Is Yoffe Div (-)			
1	22000	550	7250	90	25.00	12.41
1967	Bir Hamma-Bir Gifgafa					
	Is Tal Div		Eg 3d Inf Div and 4th Armd Div (-)			
1	10200	75	13500	550	7.35	40.74
1967	Nakhl					
	Is Sharon Div		Eg 6th Mech Div			
1	18780	60	18450	625	3.19	33.88
1967	Bir Gifgafa					
	Eg Armd Bde		Is Tal Div			
1	3500	450	3600	60	128.57	16.67
1967	Tel Fahar-Banias					
	Is Golani Bde		Syr 11th Inf Bde (+)			
1	5375	300	8160	850	55.81	104.17
1967	Rawiyeh					
	Is Ram Bde		Syr 8th Inf Bde (+)			
1	5350	150	4350	300	28.04	68.97
1967	Zaoura-Kala					
	Is Mendler's Bde		Syr 11th Inf Bde (+)			
1	5850	230	8560	500	39.32	58.41
The	Kerama					
	Is Gonen Task Force		Jor 1st Inf Div			
1	11940	201	16168	497	16.83	30.74
1973	Suez Canal Assault-North					
	Eg Second Army		Is Sinai Def Force			
1	29490	400	4455	275	13.56	61.73
1973	Suez Canal Assault-South					
	Eg Third Army		Is Sinai Def Force			
1	22850	350	3020	225	15.32	74.50
1973	Second Army Buildup					
	Eg Second Army		Is Sinai Def Force			
1	63910	800	14000	450	12.52	32.14
1973	Third Army Buildup					
	Eg Third Army		Is Sinai Def Force			
1	45160	750	10980	400	16.61	36.43

YEAR / DURATION	BATTLE / ATTACKER STRENGTH	CAS.	DEFENDER STRENGTH	CAS.	TBC/1000/DAY ATKR RATE	DFDR RATE
1973	Kantara-Firdan					
	Is Adan Div		Eg Second Army			
1	25850	700	67440	700	27.08	10.38
1973	Egyptian Offensive North					
	Eg Second Army		Is Sasson Force and Sharon Div			
1	81160	1700	43400	380	20.95	8.76
1973	Egyptian Offensive South					
	Eg Third Army		Is Magen Div (-) (+)			
1	57960	1350	28600	260	23.29	9.09
1973	Deversoir (Chinese Farm II)					
	Is Adan Div (+)		Eg 16th Div (-) (+)			
2	28900	950	36840	2400	16.44	32.57
1973	Deversoir West					
	Is Adan Div (+)		Eg Second Army (-)			
1	19600	300	18180	800	15.31	44.00
1973	Ismailia					
	Is Sharon Div		Eg Second Army (-)			
4	17000	600	23860	1800	8.82	18.86
1973	Jebel Geneifa					
	Is Adan Div (+)		Eg Third Army (-)			
3	16200	300	35633	1650	6.17	15.44
1973	Shallufa I					
	Is Adan Div (+)		Eg Third Army (-)			
1	16200	150	25600	1100	9.26	42.97
1973	Adabiya					
	Is Magen Div		Eg Third Army (-)			
1	10900	75	14620	400	6.88	27.36
1973	Shallufa II					
	Is Adan Div (+)		Eg Third Army (-)			
2	11700	150	22570	1100	6.41	24.37
1973	Suez					
	Is Adan Div (+)		Eg Third Army (-)			
2	14681	340	22570	1100	11.58	24.37
1973	Kuneitra					
	Syr 9th Inf Div (+)		Is 7th Armd Bde (-) (+)			
2	17750	350	3630	200	9.86	27.55

YEAR	BATTLE					TBC/1000/DAY	
	ATTACKER		DEFENDER			ATKR	DFDR
DURATION	STRENGTH	CAS.	STRENGTH	CAS.		RATE	RATE
1973	Ahmadiyeh						
	Syr 7th Inf Div (+)		Is 7th Armd Bde (-) (+)				
2	22750	700	5745	250		15.38	21.76
1973	Rafid						
	Syr 5th Inf Div (+)		Is 188th Armd Bde (-) (+)				
1	19525	350	4958	250		17.93	50.42
1973	Yehudia-El Al						
	Syr 5th Inf Div (+)		Is 240th Armd Div				
1	21984	500	6300	150		22.74	23.81
1973	Nafekh						
	Syr 1st Armd Div		Is 79th Armd Bde (+)				
2	12500	500	6946	250		20.00	18.00
1973	Tel Faris						
	Is 146th Armd Div (+)		Syr 5th Inf Div (+)				
3	17833	450	23750	1125		8.41	15.79
1973	Hushniyah						
	Is 240th Armd Div (-) (+)		Syr 9th Inf Div (-) (+)				
3	12733	450	14683	1125		11.78	25.54
1973	Mount Hermonit						
	Syr 7th Inf Div (+)		Is 7th Armd Bde (+)				
2	31650	1200	5395	400		18.96	37.07
1973	Mount Hermon I						
	Is Golani Bde (-)		Syr Para Bde (-)				
1	2692	50	1583	100		18.57	63.17
1973	Tel Shams						
	Is 36th Mech Div		Syr 7th Inf Div (-) (+)				
3	16100	525	19400	1200		10.87	20.62
1973	Tel Shaar						
	Is 240th Armd Div		Syr 1st Armd Div (+)				
2	14700	280	21500	900		9.52	20.93
1973	Tel el Hara						
	Ir 3d Armd Div		Is 240th Armd Div				
1	12500	450	14300	50		36.00	3.50
1973	Kfar Shams-Tel Antar						
	Is 240th Armd Div (-)		Ir 3d Armd Div				
1	11000	100	12000	200		9.09	16.67

YEAR	BATTLE					TBC/1000/DAY	
	ATTACKER		DEFENDER			ATKR	DFDR
DURATION	STRENGTH	CAS.	STRENGTH	CAS.		RATE	RATE
1973	Naba						
	Jor 40th Armd Bde (+)		Is 240th Armd Div				
1	11500	450	11000	100		39.13	9.09
1973	Arab Counteroffensive						
	Syr 9th Inf Div (-) (+)		Is 146th Armd Div				
1	35750	550	16100	160		15.38	9.94
1973	Mount Hermon II						
	Is Golani Bde		Syr Para Bde				
1	5700	150	4750	200		26.32	42.11
1973	Mount Hermon III						
	Is Golani Bde (+)		Syr Para Bde				
1	11400	100	4750	250		8.77	52.63

APPENDIX F

NATIONAL TRAINING CENTER

APPENDIX F

NATIONAL TRAINING CENTER DATABASE

The database is organized by engagement from the perspective of the participating U.S. Army battalion ("Blue") task force. The data are arranged in 9 columns.

Column	Description
Engagement	Unique number identifies each engagement. First 5 digits identify "rotation" (e.g., "8705M" cites a mechanized task force engagement during the fifth training cycle of FY87). Last 3 digits uniquely identify the particular engagement.
Posture	Five different tactical postures (defined in reference to "Blue") are identified: ▸ DSEC — Defense in Sector ▸ DEPB — Defense of a Battle Position ▸ DATK — Deliberate Attack ▸ MVTC — Movement to Contact ▸ CATK — Counterattack
Blue	
1	Descriptor of whether "Blue" task force was "modernized" (m) or "nonmodernized" (n). Modernized refers to current era of vehicles (M-1, M-2, etc.). Nonmodernized refers to the previous era of vehicles (M-60, M-113, etc.).
2	Number of "Blue" task force personnel recorded "killed-in-action."
3	Number of "Blue" task force personnel recorded "wounded-in-action."

4 Actual (recorded) strength of "Blue" task force, or average strength for an armored (719) or mechanized (708) task force as determined from After Action Review videotapes.

Red

5 Total battle casualties of "Opposing Force" (or OPFOR), here termed "Red." Determined by adding recorded personnel ("dismounted infantry") casualties to vehicle crew casualties (evaluated in same manner as crew casualties of "Blue" vehicles – total crew defined as casualties for each principal ground combat vehicle "killed").

6 OPFOR unit personnel strength. In several cases, strength directly recorded. In other cases, strength determined by adding recorded "dismounted infantry" strength to vehicle crew numbers for main ground combat vehicles (listed in OPFOR start strength).

7 OPFOR unit type. Often recorded. When not recorded, imputed from factors such as OPFOR unit mission (posture), numbers and types of OPFOR vehicles in start strength, comparison with other known (recorded) OPFOR unit types by mission/start strength/composition, etc. [Note: unit often identified as augmented ("+") or decremented ("–"), which apparently accounts for echelons sometimes showing overlapping strengths.]

"mrr" – Motorized Rifle Regiment
"mrb" – Motorized Rifle Battalion
"mrc" – Motorized Rifle Company

ENGAGEMENT	POSTURE	BLUE				RED		
		1	2	3	4	5	6	7
8705M024	DSEC	m	036	055	0708	116	686	mrr
8701M025	DSEC	m	032	067	0708	045	570	mrr
8706M032	DSEC	n	028	061	0708	108	673	mrr
8708M026	DSEC	n	071	121	0708	181	843	mrr
8608M009	DSEC	n	014	039	0708	255	519	mrr
8607A009	DSEC	m	041	031	0719	315	605	mrr
8601A007	DSEC	n	046	073	0719	314	616	mrr
8614A027	DSEC	n	016	031	0719	312	663	mrr
8606A009	DSEC	n	047	105	0719	213	581	mrr
8610A032	DSEC	n	064	110	0719	204	641	mrr
8609A014	DSEC	n	027	100	0719	429	691	mrr
8612M014	DEBP	n	059	143	0708	300	758	mrr
8605A010	DEBP	m	038	026	0719	429	533	mrr
8606M015	DEBP	n	042	069	0708	062	690	mrr
8601A025	DEBP	n	029	031	0719	171	636	mrr
8608A010	DEBP	n	046	102	0719	446	646	mrr
8613A007	DEBP	n	031	063	0719	421	724	mrr
8701M006	DATK	m	034	082	0708	017	145	mrc
8605M003	DATK	m	026	065	0708	057	235	mrb
8601M024	DATK	n	023	035	0485	281	446	mrb
8601M026	DATK	n	027	061	0542	170	300	mrb
8602M006	DATK	n	019	037	0573	138	155	mrc
8603M008	DATK	n	063	080	0548	131	216	mrc
8603M009	DATK	n	033	092	0561	104	130	mrc
8604M001	DATK	n	059	124	0708	116	234	mrb

		BLUE				RED		
ENGAGEMENT	POSTURE	1	2	3	4	5	6	7
8604M003	DATK	n	040	090	0708	082	165	mrb
8604M009	DATK	n	055	101	0708	112	207	mrc
8604M012	DATK	n	050	078	0708	114	126	mrc
8609M001	DATK	n	050	079	0708	039	159	mrc
8609M002	DATK	n	015	022	0708	160	270	mrb
8609M003	DATK	n	034	073	0708	020	186	mrb
8613M001	DATK	n	039	225	0708	038	142	mrc
8614M003	DATK	n	023	081	0708	072	272	mrb
8702M012	DATK	n	017	047	0708	112	181	mrc
8702M020	DATK	n	027	071	0708	084	192	mrc
8703M017	DATK	n	018	046	0708	045	185	mrc
8703M019	DATK	n	024	035	0708	073	188	mrc
8704M004	DATK	n	022	056	0708	114	393	mrr
8706M004	DATK	n	026	064	0708	059	194	mrc
8706M026	DATK	n	033	073	0708	103	198	mrc
8606M018	DATK	n	085	102	0708	027	142	mrc
8708M028	DATK	n	063	118	0708	109	274	mrb
8608M024	DATK	n	026	061	0708	101	364	mrr
8708A015	DATK	n	031	063	0719	054	152	mrc
8614M005	MVTC	n	030	131	0708	216	341	mrb
8706M006	MVTC	n	036	081	0708	108	673	mrr
8606M016	MVTC	n	019	066	0708	117	170	mrc
8701A011	MVTC	m	009	017	0719	068	126	mrc
8614A023	MVTC	n	039	089	0719	221	304	mrb
8608A032	MVTC	n	055	145	0719	217	249	mrb

ENGAGEMENT	POSTURE	BLUE				RED		
		1	2	3	4	5	6	7
8610A025	MVTC	n	078	112	0719	129	156	mrb
8608M027	CATK	n	005	012	0708	057	083	mrc
8605A002	DATK	m	029	063	0719	053	150	mrb
8605A003	DATK	m	009	017	0719	135	209	mrb
8701A004	DATK	m	025	075	0719	056	129	mrb
8701A013	DATK	m	023	070	0719	215	376	mrb
8705A003	DATK	m	014	044	0719	121	641	mrr
8705A013	DATK	m	020	070	0719	074	173	mrc
8707A003	DATK	m	029	107	0719	111	655	mrr
8707A021	DATK	m	037	075	0719	117	193	mrb
8707A034	DATK	m	027	048	0719	059	207	mrc
8609A003	DATK	n	044	098	0719	066	273	mrb
8610A020	DATK	n	044	125	0719	068	157	mrc
8610A034	DATK	n	044	108	0719	052	113	mrc
8610A037	DATK	n	032	093	0719	063	137	mrc
8612A006	DATK	n	028	048	0719	055	155	mrc
8612A014	DATK	n	037	093	0719	131	157	mrc
8703A001	DATK	n	050	100	0719	050	185	mrc
8703A005	DATK	n	019	066	0719	070	114	mrc
8613A003	DATK	n	049	108	0719	106	346	mrb
8613A004	DATK	n	077	022	0719	058	124	mrc
8702A002	DATK	n	031	093	0719	117	350	mrb
8706A014	DATK	n	014	067	0719	061	134	mrc
8706A016	DATK	n	019	045	0719	064	128	mrc
8606A001	DATK	n	061	160	0719	082	150	mrc

ENGAGEMENT	POSTURE	BLUE 1	BLUE 2	BLUE 3	BLUE 4	RED 5	RED 6	RED 7
8608A001	DATK	n	037	091	0719	096	154	mrb
8608A026	DATK	n	077	137	0719	170	193	mrb
8601A009	DATK	n	034	068	0719	236	474	mrb
8601A017	DATK	n	044	073	0719	174	411	mrb
8602A008	DATK	n	059	077	0719	101	139	mrc
8603A003	DATK	n	038	071	0719	047	062	mrc
8602A010	DATK	n	030	052	0719	185	227	mrb
8603A006	DATK	n	042	048	0719	069	162	mrr
8612A006	DATK	n	046	065	0719	042	150	mrc
8614A013	DATK	n	042	101	0719	032	104	mrc
8614A038	DATK	n	022	050	0719	170	324	mrb
8701M003	MVTC	m	034	067	0708	097	570	mrr
8701M027	MVTC	m	042	087	0708	162	326	mrb
8707M015	MVTC	m	029	088	0708	112	148	mrb
8707A032	MVTC	m	025	050	0719	077	188	mrb
8701A009	DSEC	m	046	065	0719	355	684	mrr
8701A020	DSEC	m	041	043	0719	534	731	mrr
8705A009	DSEC	m	018	076	0719	296	597	mrr
8707A029	DSEC	m	050	045	0719	335	797	mrr
8602A003	DSEC	n	048	092	0719	422	532	mrr
8613A006	DSEC	n	019	038	0719	070	762	mrr
8702A009	DEBP	n	021	084	0719	285	651	mrr
8702A025	DSEC	n	023	092	0719	416	717	mrr
8704A010	DEBP	n	054	090	0719	347	671	mrr
8704A028	DSEC	n	019	076	0719	416	746	mrr

ENGAGEMENT	POSTURE	BLUE 1	2	3	4	RED 5	6	7
8706A020	DSEC	n	014	037	0719	399	656	mrr
8706A024	DSEC	n	034	041	0719	255	733	mrr
8708A012	DSEC	n	012	015	0719	291	751	mrr
8710A014	DSEC	n	024	041	0719	301	731	mrr
8801A009	DSEC	n	040	062	0719	345	873	mrr
8801A028	DSEC	n	066	257	0719	364	746	mrr
8608A037	DSEC	n	025	050	0719	484	565	mrr
8612A012	DSEC	n	042	117	0719	198	717	mrr
8703A004	DSEC	n	046	057	0719	274	611	mrr
8801M009	DSEC	n	040	062	0708	345	873	mrr
8802M017	DSEC	n	059	076	0708	174	788	mrr
8802M032	DSEC	n	038	012	0708	438	812	mrr
8803M009	DSEC	n	048	067	0708	264	854	mrr
8804M015	DSEC	n	038	082	0708	141	713	mrr
8806M018	DSEC	n	051	084	0708	354	848	mrr
8808M018	DSEC	n	032	100	0708	159	753	mrr
8808M035	DSEC	n	032	102	0708	168	577	mrr
8810M014	DSEC	n	039	082	0708	289	776	mrr
8813M035	DSEC	n	014	049	0708	325	775	mrr
8814M017	DSEC	m	033	063	0708	399	800	mrr
8601M005	DEBP	n	037	084	0675	312	685	mrr
8710M026	DSEC	n	046	065	0708	095	680	mrr
8609M001	DSEC	n	092	054	0708	107	671	mrr
8609M014	DSEC	n	043	062	0708	363	650	mrr
8703A015	DEBP	n	061	033	0719	255	648	mrr

		BLUE				RED		
ENGAGEMENT	POSTURE	1	2	3	4	5	6	7
8607M019	DSEC	m	017	028	0708	150	560	mrr
8606M005	CATK	n	034	095	0708	072	105	mrc
8603M007	MVTC	n	050	113	0565	272	389	mrb
8607A002	MVTC	m	069	120	0719	075	181	mrc
8601A008	MVTC	n	043	054	0719	118	310	mrr
8712A021	MVTC	n	034	063	0719	078	135	mrc
8701M010	DEBP	m	056	095	0708	145	658	mrr
8601M007	DEBP	n	031	036	0397	134	149	mrc
8602M004	DEBP	n	048	064	0606	134	274	mrb
8602M010	DEBP	n	051	054	0613	231	550	mrr
8613M004	DEBP	n	050	213	0708	261	625	mrr
8706M014	DEBP	n	044	090	0708	163	707	mrr
8609A025	DEBP	n	060	165	0719	305	677	mrr
8709M013	DSEC	m	073	079	0708	156	792	mrr

APPENDIX G

STATISTICAL ANALYSIS

APPENDIX G

STATISTICAL ANALYSIS

GENERAL CONSIDERATIONS

The essential question to be addressed here is whether empirical evidence of ground forces casualty rates since World War II indicates that rates have increased significantly since that time. Our analysis relies upon three available data bases. These are obtained from combat operations both in World War II and the Middle East Wars of 1967 and 1973, and from recent field training exercises at the U.S. Army National Training Center (NTC).

The analysis aims at assessing and comparing casualty rates that have occurred in actual combat operations and field exercises. This is in contrast to what may be called "technological" casualty rates. These latter rates are ascribed to operations, but actually they are only imputed values based upon munitions effects of specific weapon systems as determined under narrowly defined experimental conditions. Moreover, the imputation process typically is founded upon hypothesized interactive battlefield relationships between many munition whose individual effects have in fact only been evaluated independently.

The analysis is based on the fundamental observation that casualties occur in "pulses." At any echelon, when observed over time, combat is characterized by periods of high activity, preceded and followed by periods of lesser activity. In terms of observable casualty experience, this means that casualty rates also will follow this pattern. Periods of relatively high rates are preceded and followed by periods of lower rates. The mathematical model of a process of events occurring over time (a point process) specifies a non-negative valued function of time $r(t)$ which represents the instantaneous rate of occurrence of a single event at each time t. In the present context, the "events" are casualties. A *pulse* is defined to be any portion of the theoretical rate function which is relatively high, represented graphically by a local maximum of $r(t)$.

In practice, the smallest time period over which reliable casualty and strength data are available is 1 day. (One exception is a small data set of uncertain reliability.) One day is therefore the smallest available "window" on the underlying phenomenon, since of course the exact occurrence times of the individual casualties are not known. Thus, statistically, we define casualty rates in terms of 1-day periods, i.e., on the basis of the best available data. Consequently, in terms of the data we define a *pulse* as a relatively high 1-day casualty rate. Since intense combat may occur over a period of several days, these 1-day pulses frequently are observed to occur in clusters. One such cluster may be regarded as a single *multi-day pulse*, since of course it indicates an extended period of intense combat, rather than several distinct shorter periods.

A closely related point is that in cases where the available data are the number of casualties or casualty rates over a longer period of time (e.g., 10-day average casualty rates), the daily pulses and variation of the underlying casualty process are unknown. That is, a single value representing several days, after being converted to an average daily rate, contains less information than the actual daily rates.[1]

Formally we define casualty rate to be X = # casualties/thousand division personnel/day. Given the above considerations and using the available databases, the following comparisons are carried out:

- Middle East wars to World War II using one-division/one-day rates
- NTC to World War II using one-battalion/one-day rates.

An important point is that all of the casualty rates in these comparisons are actual 1-day values.

Other data sets related to the question being addressed here exist, in particular U.S. Army casualty data from the Korean War. However, this data set is of no practical use in the present analysis due to the fact that of the 85 operations for which casualty rates are available, only two are one-division/one-day rates. Similarly, no

[1]This problem is associated with (1) virtually all the German data, (2) nearly all the Korean War data, and (3) a large minority of the Middle East data.

formal use could be made of a portion of the Middle East data as it also provides only averaged daily rates.[2]

DATA SETS: POPULATIONS OR SAMPLES?

A fundamental issue in making the statistical comparisons is whether the respective sets of values of X comprise populations or samples. The NTC values may properly be regarded as a sample of field exercises, recognizing that these exercises are conducted under relatively well-defined and consistent conditions, and that they do not arise from actual combat. With regard to the data sets from World War II and the Middle East, however, this issue turns on the question of whether there exists an underlying phenomenon which may be called "modern ground warfare."

One view is that the respective sets of World War II and Middle East values comprise populations due to prima facie differences, such as nationalities, terrain, technological eras, etc. In this case formal tests of hypotheses are inappropriate since the summary statistics are population parameters. Thus, practical differences can be assessed by simply comparing corresponding population parameters and graphical representations.

A second view is to treat these data sets as samples. This view arises from the possibility that each war is an individual realization of a more general phenomenon – "modern ground warfare." This of course raises the question of whether there exists an even more general phenomenon called "ground warfare." This would suggest comparisons among military operations occurring in wars from different centuries. We do not address this more general issue.

Under the second point of view, however, each of these two data sets may properly be regarded as a sample from the population of all X values resulting from modern ground warfare, with the proviso that they are representative of different strata within this population. However, in this case each sample is a census of its stratum, subject to the foregoing criteria for defining X. Here, formal comparative statistical tests of hypotheses are appropriate.

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[2]See Chapter 10 for other related comments, and Appendices D and E for the respective Korean War and Middle East wars data.

Our analysis addresses the data sets from both points of view – i.e., as either populations (except the NTC set) or samples.

In both cases, the comparisons are carried out via graphical representations of the data sets. The graphical methods employed here are histograms, survivor curves and boxplots. We use survivor curves rather than the more commonly used cumulative distribution function plots because when the survivor curves of two groups (populations or samples) are superimposed, the group which has on average *larger* numerical values also has on average the *higher* of the two curves, and thus the graphical comparison via survivor curves is visually correct.

ARCHIEVING COMPARABLE DATA SETS

Our two sets of comparisons – Middle East versus World War II, and NTC versus World War II – required that the data be comparable from both the military and the statistical points of view. Militarily, the focus in both cases is on intense combat, at the division and battalion levels, respectively. Given data drawn from such contexts, the variable must be a well-defined 1-day observation.

The details of the processes for selecting data for the two comparisons are described in Chapter 10. The processes for selecting militarily appropriate data from the very large sets of experiences available from World War II are rather complex. For both comparisons, criteria for selecting the World War II data were necessary in order that the military settings in which the data occurred match at least reasonably well the settings represented in the opposing data sets (i.e., in the Middle East and NTC sets). In both comparisons care was taken not to choose World War II data only for days on which rates were at some predefined high level.

MIDDLE EAST VERSUS WORLD WAR II

In the case of the Middle East versus World War II comparison, the process for selecting the World War II data focused first on identifying suitable periods of time (of from 1 to 3 weeks) where a corps-level force experienced intense combat, and then on division experiences within the corps. The division focus was necessary because the Middle East data set represents combat by single divisions. The process was structured to ensure that World War II division data reflect at least roughly the intensity of combat focus of the Middle East divisions – which usually fought separate and identifiable 1-day battles, a circumstance hardly representative of the World War II environment. Once the World War II division was identified, all its rates during the period were used that exceeded only a relatively low minimum of

5/1000/day (previously established in other analysis) as a division day rate representing a reasonable minimum level of significant casualty experience.

NATIONAL TRAINING CENTER VERSUS WORLD WAR II

The NTC versus World War II comparison rests on a similarly complex but different process for selecting appropriate World War II data. By Army design, the NTC observations are intense 1-day pulses at the battalion level. We extracted three specific (nested) subsets of intense 1-day battalion-level pulses from World War II.

The process (again, described in Chapter 10) of selecting the comparable World War II observations was carried out according to the following algorithm.

- Attention was restricted to those divisions and battalions for which actual 1-day rates (i.e., not averaged) were available. Let D_i denote a 1-day casualty rate of a given division, and a 1-day casualty rate of battalion j within that division by B_{ij}. Attention was further restricted to those divisions for which D_i was at least 5/1000/day.
- The ratio $R_{ij} = B_{ij}/D_i$ was computed for all battalion days. All battalion rates for which R_{ij} was ≥ 4 were included in the data set.
- For the set of battalion rates for which $R_{ij}<4$, a particular B_{ij} was also included in the data set if
  - for an infantry battalion, $B_{ij}>60$
  - for an armored or armored infantry battalion, $B_{ij}>30$.

This process produced a total of 51 values.

This process first related battalion rates to their respective division rates for the days in question in order to determine a ranking of battalion casualty rate intensities. The set of 51 intense 1-day battalion rates was thus defined using both this ranking scheme and the requirement that the division casualty experiences from which the battalion rates were drawn were themselves at least 5/1000/day (the same level used as a minimum threshold in the Middle East versus World War II comparison). Two (nested) subsets of this set were also defined for use as alternative division threshold rates. These alternatives were established in order to select battalions whose division rates probably more closely resembled what might be expected of a division set into the intense environment (the immediate flank of a major attack sector) assumed in the NTC scenario. Division rates of 15 and 20 were selected (again, on the basis of previous work with World War II data) as reasonable thresholds of such intensity. Thus, the three nested subsets of one-battalion/one-day rates are identified by their respective division-level intensity cutoff values (represented below by D) of 5, 15, and 20.

Thus we have established data sets enabling the following comparisons:

Data set	Comparison
(1)	Division-level Middle East Wars' data to World War II data
(2a)	Battalion-level NTC data to World War II data with cutoff $D \geq 5$
(2b)	Battalion-level NTC data to World War II data with cutoff $D \geq 15$
(2c)	Battalion-level NTC data to World War II data with cutoff $D \geq 20$

THE COMPARISONS: VIEWED AS POPULATIONS

Middle East versus World War II

We compared the combined Arab-Israeli casualty rates to the U.S. World War II division rates. We also made separate comparisons of the Israeli to World War II and Arab to World War II data sets. The summary statistics are provided in Table G-1.

TABLE G-1

ONE-DIVISION/ONE-DAY SUMMARY STATISTICS

Statistic	WWII	Combined Arab-Israeli	Arab	Israeli
Number of observations	122.00	34.00	16.00	18.00
Mean	23.93	28.59	42.38	16.30
Standard deviation	22.80	29.73	37.80	10.90
Skewness	2.72	2.94	2.20	1.06
Maximum	149.00	138.00	138.00	36.00
75th percentile	30.00	35.00	40.00	21.00
Median	16.00	19.50	32.00	10.50
25th percentile	10.00	10.00	20.50	9.00
Minimum	5.00	6.00	15.00	6.00

Frequency distributions in the form of histograms, survivor curves, and box plots are shown (for both the Middle East versus World War II and the NTC versus World War II comparisons) at the end of this appendix.

- *Arab-Israeli (Combined) versus World War II.* There is a general similarity of the frequency distributions. Both histograms in Figure G-1: (1) are skewed to the right with comparable maximum values (138 versus 149); (2) have modes between 5 and 10; and (3) have comparable values at the mean (28.59 versus 23.93) and median (19.5 versus 16). The similarities are further illustrated in the survivor curves (Figure G-2) and the box plots (Figure G-3). The clear impression is that of agreement between the two distributions, even though the Arab-Israeli rates are about 20 percent higher at the mean and median. The absolute difference in rates at the midpoints is only 3 – 4/1000/day, which for forces at the division level within a rate range of 16 – 28/1000/day is insignificant practically. The respective values are close enough across the full range of their distributions that we conclude there is no practical difference between the rates. Not surprisingly, the statistical tests performed later in the appendix – viewing the data sets as samples – support this conclusion.

- *Arab and Israeli (Individually) versus World War II.*[3] Arab casualty rates were noticeably higher than the World War II rates in all respects, with the exception of the maximum value: the mean (42 versus 24), median (32 versus 16), 75th percentile (40 v. 30). See Figure G-4. Thus, we conclude the Arab rates are significantly higher than the World War II rates. Table G-1 and Figure G-5 show that the Israeli rates were lower than the World War II rates. The World War II rates are about 50 percent higher at the mean, median, and 75th percentile. We therefore conclude that the Israeli rates are significantly lower than the World War II rates.

NTC versus World War II

The most interesting feature here is the contrast between the well-behaved, near-Gaussian, small-variance distribution of the NTC data and the irregularly shaped, highly skewed, and large-variance distribution of the World War II data. (See the histograms in Figure G-6.) The contrast reflects the differences between the relatively highly controlled, experimental environment of the NTC field exercises and the real world of war.

The real world data are distinguished by a wide range of rates with a significant proportion of extremely high values (heavy-tailed). For example, for the case of

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[3] We provide only survivor curves for this comparison. See Figures G-4 and G-5.

World War II battalions where the division threshold is ≥ 15 (see Figure G-7), about 25 percent of the rates are greater than 310, whereas only about 3 percent of the NTC rates exceed that value. Since the World War II subsets are nested, raising the threshold to ≥ 20 further separates the two distributions (Figure G-8). Even when the threshold is lowered to ≥ 5 [where the World War II median is slightly smaller than that for the NTC (132 versus 156.5)] the separation at the upper end is still large. (See Figure G-9). Yet another view of the distributions is provided by the box plots in Figure G-10. (Summary statistics are provided in Table G-2.) All three subsets of the World War II data contain proportionately more of the higher rates than does the NTC data.

TABLE G-2

ONE-BATTALION/ONE-DAY SUMMARY STATISTICS

Statistic	NTC	WWII $_{Div \geq 5}$	WWII $_{Div \geq 15}$	WWII $_{Div \geq 20}$
Number of observations	139	51	38	33
Mean	163.74	173.19	214.05	231.16
Standard deviation	69.47	140.51	140.99	143.26
Skewness	0.95	1.64	1.51	1.40
Maximum	449.00	687.07	687.07	687.07
75th percentile	195.00	205.10	308.67	319.73
Median	156.50	132.00	165.00	183.04
25th percentile	123.00	74.90	113.80	132.00
Minimum	24.00	27.39	61.40	83.80

The statistical tests we perform in the next section of this appendix show that the NTC rates are not higher on average than the World War II rates. Only the case for World War II battalions drawn from divisions with rates ≥ 5 shows even a marginally significant difference; but the difference is inconclusive since the NTC median is higher (156 versus 132) while the World War II mean is also higher (173 versus 164).

Recognizing that the test we employ below is insensitive to extreme values in the tails of the distributions being examined, we believe it is safe to conclude that

NTC training data as recent as 1988 offer no empirical evidence whatever that U.S. casualty rates in clashes between U.S. and Soviet-style forces are higher at the battalion level than rates seen for battalions in World War II.

THE COMPARISONS: VIEWED AS SAMPLES

Since all data sets (except NTC) exhibit substantial skewness, and thus clearly are not normally distributed, t-tests are inappropriate for comparisons of average behavior. The two-sample Wilcoxon rank sum test was used for all formal tests of hypotheses. This test is distribution-free and thus robust against a broad variety of circumstances, including non-normality, skewness, heavy tails and outliers. Moreover, for comparing populations 1 and 2, it tests the intuitively appealing general null hypothesis that prob $[X_{(1)} < X_{(2)}] = 0.5$, where $X_{(1)}$ and $X_{(2)}$ represent random variables from populations 1 and 2, respectively.

Hypotheses

The hypothesis for each test may be formulated in two ways, each of which reflects a particular viewpoint. A one-sided test of

$$H_0: \quad \text{prob}\,[X_{\text{World War II}} < X_{\text{NTC}}] \geq .5$$

$$\text{versus} \quad H_A: \quad \text{prob}\,[X_{\text{World War II}} < X_{\text{NTC}}] < .5$$

reflects the a priori view that technological developments, etc., since World War II would result in an increased casualty rate in a NATO-Soviet ground war in the European theater, given that the NTC values are representative of these anticipated rates. In contrast, a two-sided test of

$$H_0: \quad \text{prob}\,[X_{\text{World War II}} < X_{\text{NTC}}] = .5$$

$$\text{versus} \quad H_A: \quad \text{prob}\,[X_{\text{World War II}} < X_{\text{NTC}}] \neq .5$$

is motivated by the a priori view that the casualty rates of such a third world war (World War III) could be either higher or lower than those actually experienced in World War II. (The corresponding hypothesis for comparing the Middle East data to World War II data would be identically stated, except that X_{ME} would appear in place of X_{NTC} in the formulation.)

Recall that X represents 1-day pulse or peak casualty rates. In the first (one-sided) case, acceptance of H_0 implies the conclusion that the NTC rates, and hence the anticipated rate for "World War III," would not be less than the rates of World War II. Rejection of H_0 implies the converse. In the second (two-sided) case, acceptance of H_0 simply implies that there is no difference in the two rates, while rejection of H_0 implies there is a difference. However, if H_0 is rejected in this second case, in practice one would conclude that the sample having the larger mean (or median) in fact has the higher casualty rates.

An important statistical consideration is that the values within each of the three samples of World War II battalion-level casualty rates may be correlated. This is due to the fact that the set of battalions assigned to the same division do not operate independently. Moreover, the selection algorithm described above for ensuring comparability to the NTC values also introduces a dependency among the X values of the World War II sample. The same sort of consideration would apply to both the World War II and Middle East division-level casualty data sets, because in each case at least some divisions were operating interactively. It may be argued that such dependence is on average either positive or negative, depending upon the specific circumstances of the combat scenario for units operating interactively. The effect of this nonindependence on the tests is that for each test statistic the actual variance may be either larger or smaller than the computed value. Consequently, the test may be either statistically conservative or anti-conservative, i.e., the true p-value may be smaller or larger than the computed value. Thus, each test may be either more or less significant than the numerical results would indicate.

In each case, the sample sizes are reasonably large enough to invoke the central limit theorem to provide an approximate distribution theory for the usual test statistic for comparisons of two population means. This approach would allow relatively straightforward computation of the "correct" variance of each sample. Equivalently, one would need to assume exchangeability, at least up to second order. Given the foregoing considerations, however, this assumption would very difficult to justify.

Test Results

The numerical results and conclusions of the four comparisons are as follows:

Case (1): Division-level Middle East data to World War II data:

One-sided: $p = 0.1270$

Two-sided: $p = 0.2541$

There is no significant difference from either the one-sided or two-sided viewpoint.

Case (2a): Battalion-level NTC data to World War II data with cutoff $D \geq 5$:

One-sided: $p = 0.0665$

Two-sided: $p = 0.1330$

Only the one-sided test is significant, although at a marginal level. Since $\text{mean}_{\text{NTC}} = 163.74 < 173.19 = \text{mean}_{\text{World War II}}$, but the $\text{median}_{\text{NTC}} = 156.5 > 132 = \text{median}_{\text{World War II}}$, i.e., these two averages present conflicting evidence, we cannot conclude there is any difference in rates.

Case (2b): Battalion-level NTC data to World War II data with cutoff $D \geq 15$:

One-sided: $p = 0.1209$

Two-sided: $p = 0.2418$

At this cutoff, there is no significant difference from either viewpoint, although we can see from Table G-1 that the World War II median, mean, and 75th percentile are all numerically greater than the corresponding NTC values.

Case (2c): Battalion-level NTC data to World War II data with cutoff $D \geq 20$:

One-sided: $p = 0.0184$

Two-sided: $p = 0.0368$

At this cutoff, the computed p-values indicate that both tests are highly significant. Moreover, both the mean and median of the World War II data exceed the corresponding values for the NTC data. This leads to the conclusion that the World War II casualty rates are higher than the NTC casualty rates.

NOTE REGARDING EXPECTATIONS OF COMPARED CASUALTY RATES: An important consideration arises when interpreting the results of any comparison of the casualty rates for one-division/one-day tactical events in the two combat experiences.

Consideration of the nature of combat leads to the conclusions that two units operating in close proximity have casualty rates, say X and Y, which (1) have correlation which (2) is simultaneously pulled in both the positive and negative directions. The fact that an attacking commander will attempt to focus his effort, hence direct his primary attack effort on only one of the two units, would cause X and Y to be negatively correlated. At the same time, if the unit attacked is within the attack sector boundaries of a higher echelon overall attacking force, then due to the proximity of the two units it is likely that both units would suffer higher than average casualties (at the least, the second unit would be strongly "fixed" by some portion of the attacker's forces), and this would cause X and Y to be positively correlated. It is unclear whether, accounting for both of these aspects of the phenomenon, on balance the correlation should be either positive or negative. On the other hand, it would be wholly unreasonable to argue that X and Y are independent.

To these general considerations of the nature of casualty rates must be added another that concerns the broader scenario within which a casualty rate or set of rates occurs. Two such general scenarios are the operational-level setting (such as World War II) and the strictly tactical-level setting (such as the Middle East conflicts), within both of which tactical events occur. Our analysis leads to the expectation that on average tactical rates in the latter setting would be higher than tactical rates in the former. This is due to the fact that the combat phenomena which would give rise to negative associations between the casualty rates of units in close proximity (e.g., the focus of an attack described above) tend to be more likely and have a greater effect on tactical casualty rates in the strictly tactical-level setting. In contrast, tactical events that occur within the more complex operational-level setting tend on average to be less capable of local focus.[4]

[4]There have this century been two major attempts (excluding non-conventional force applications) at addressing this difficulty at the operational level, the German *Blitzkrieg* and the Soviet development of the operational art. Each attempts to overcome this seeming property of activity at the operational level that dissipates combat power and requires special methods to gain and sustain combat focus. In the case of certain applications of the Soviet operational art these methods may result in a very narrow penetration sector along a broad front; in this penetration (or "breakthrough") sector the general tendency cited above (for less focus on average at the operational level) is reversed at the focal point in that narrow sector. Such great focus is achieved that the operational front may be disrupted altogether.

Thus we would expect tactical rates in the Middle East to be higher than tactical rates in World War II. This expectation is made stronger still by the fact that the 1-day rates in the Middle East data set represent individual 1-day battles, rather than only 1-day rates drawn from longer battles as in the World War II data set.

One practical implication of this is that a statistically significant difference in two such sets of rates would not necessarily lead to the conclusion that were divisions in the tactical-level scenario (i.e., those with the higher average rates) to be placed in the operational-level scenario, their rates would also be higher there. That is, we would expect that the new divisions put into the operational-level environment would tend to have casualty rates characteristic of tactical events within an operational-level environment.

The question is how much higher the tactical scenario rate would need to be to lead one to conclude that tactical rates in a "World War III" operational scenario would be significantly higher than are the observed tactical rates in the World War II operational scenario. We know of no objective measure to answer this, but we strongly believe that they would need to be dramatically higher. The available data for World War II and the Middle East, viewed either in terms of average values or distributions, show a difference nowhere near this level. Even if the statistical test result had shown the Middle East casualty rate to be statistically significantly higher, the magnitude of the difference is far too small to be of any practical significance.

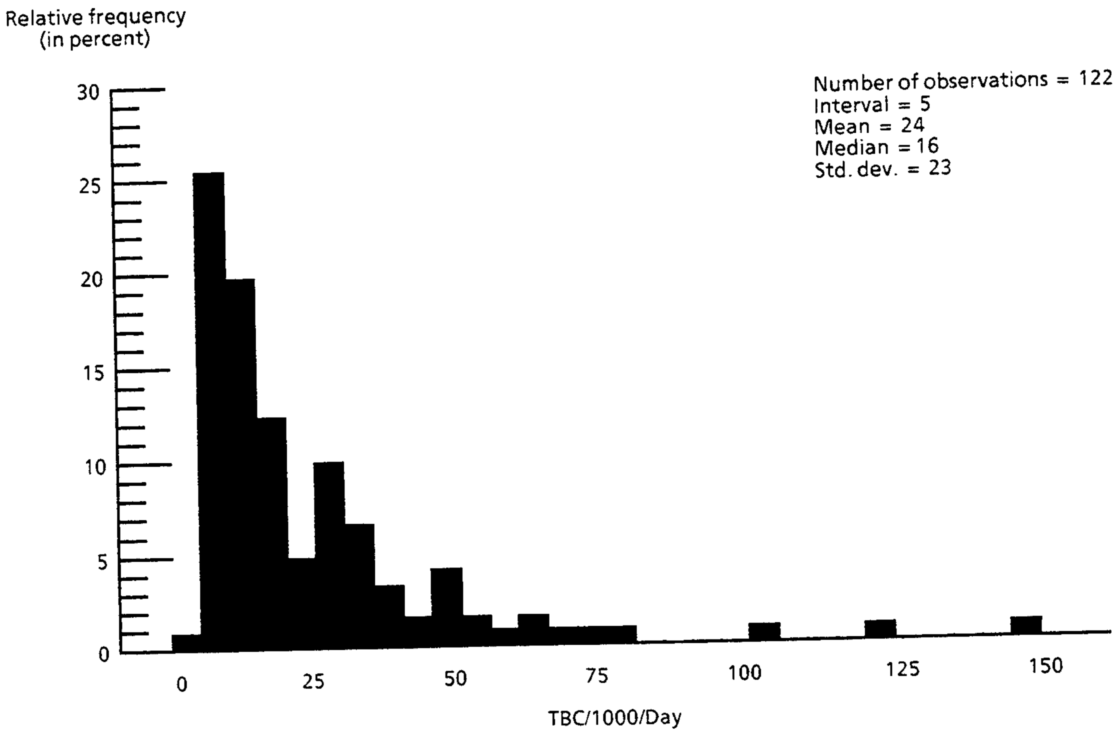
Further Considerations. Three further considerations arise.

First, recall that due to possible dependence among the World War II sample values the above tests may be either conservative or anti-conservative. The conclusion that the World War II rates are on average higher in case (2c) must be tempered by this consideration. Aside from the medians in case (2a), all the mean and median World War II battalion-level casualty rates are higher than the corresponding NTC values. Thus a more highly significant test result (smaller p-value) would lead to the conclusion that the World War II casualty rates are on average higher than the NTC rates. A less significant test result would of course lead to the conclusion of no difference. Thus, it is clearly *not* the case that the NTC rates are higher on average than the World War II rates.

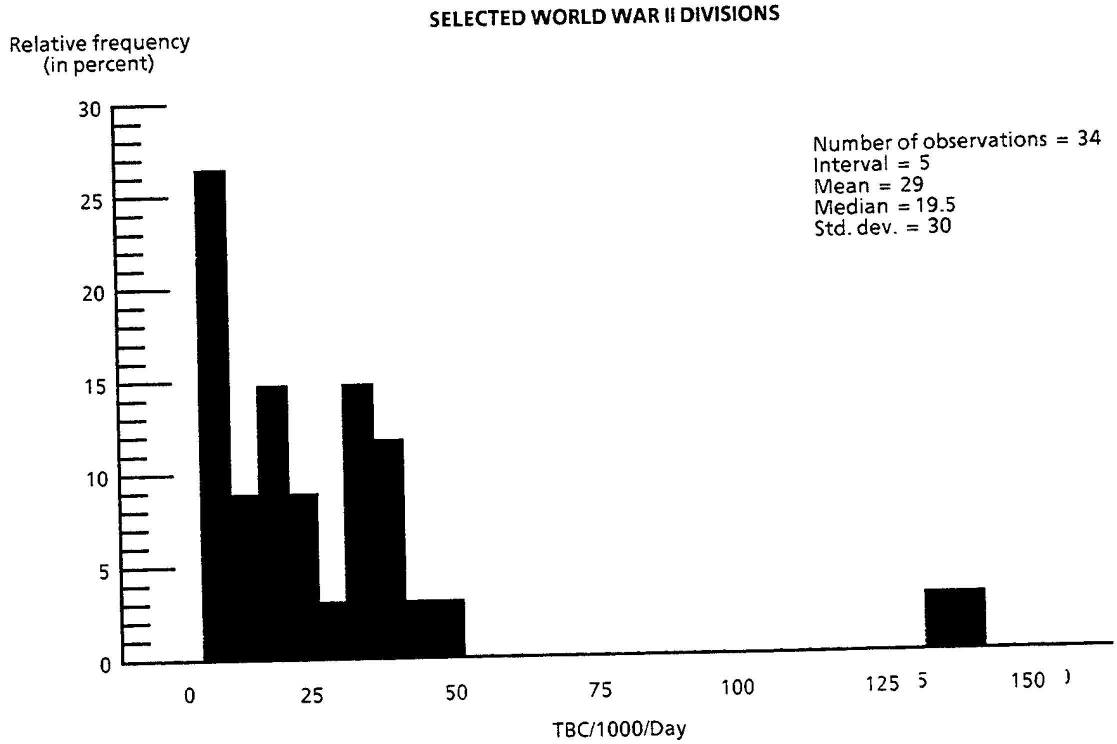
The same sort of considerations would apply to the comparison in Case (1). Specifically, a negative dependence among the X values in either the World War II or Middle East division-level sample would produce a more significant test result. A positive dependence simply produces an even less significant result than that obtained.

Second, it is important to observe that while the sample sizes of the NTC data and World War II data at the division level are large, the other four samples are of moderate sizes. Consequently, all of the above tests have moderate power, i.e., they are only reasonably likely to detect a difference if one is actually present, but not highly likely to do so. Thus, for example, the non-significant test result of case (2b) could prove significant if a larger sample were available.

Finally, as discussed in Chapter 8, the official records from which the World War II division casualty data are obtained do not in fact reflect the actual experience of the 106th Infantry Division on December 19, 1944. The rationale for retaining and sometimes using this recorded rate was discussed in that chapter. The preceding analyses are based on the recorded value of 80 for that division on that day. It may be of interest to ask what the effect would be of revising upward the recorded 1-day value of 80, to reflect more closely the actual events on that day. From this viewpoint, the casualty rate is recomputed based upon imputing a number of casualties that reflects the surrender of two of the division's three combat regiments to the enemy on that day. The recomputed value is 577. The effect of this change is to extend the upper end of the World War II frequency distribution further to the right, reinforcing the earlier conclusion that the Middle East rates are not higher. For example, the mean shifts from 23.93 to 28.0.



SELECTED WORLD WAR II DIVISIONS



ARAB AND ISRAELI DIVISIONS

FIG. G-1. HISTOGRAMS OF U.S. AND ARAB-ISRAELI CASUALTY RATES

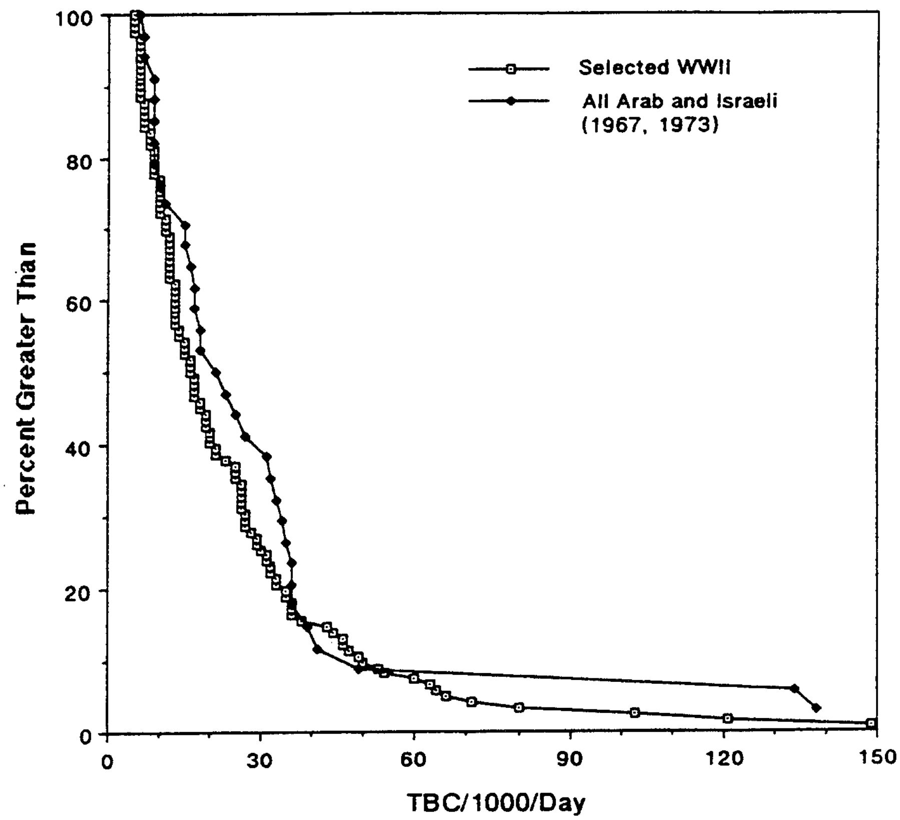


FIG. G-2. SURVIVOR CURVES OF SINGLE-DIVISION/SINGLE-DAY CASUALTY RATES

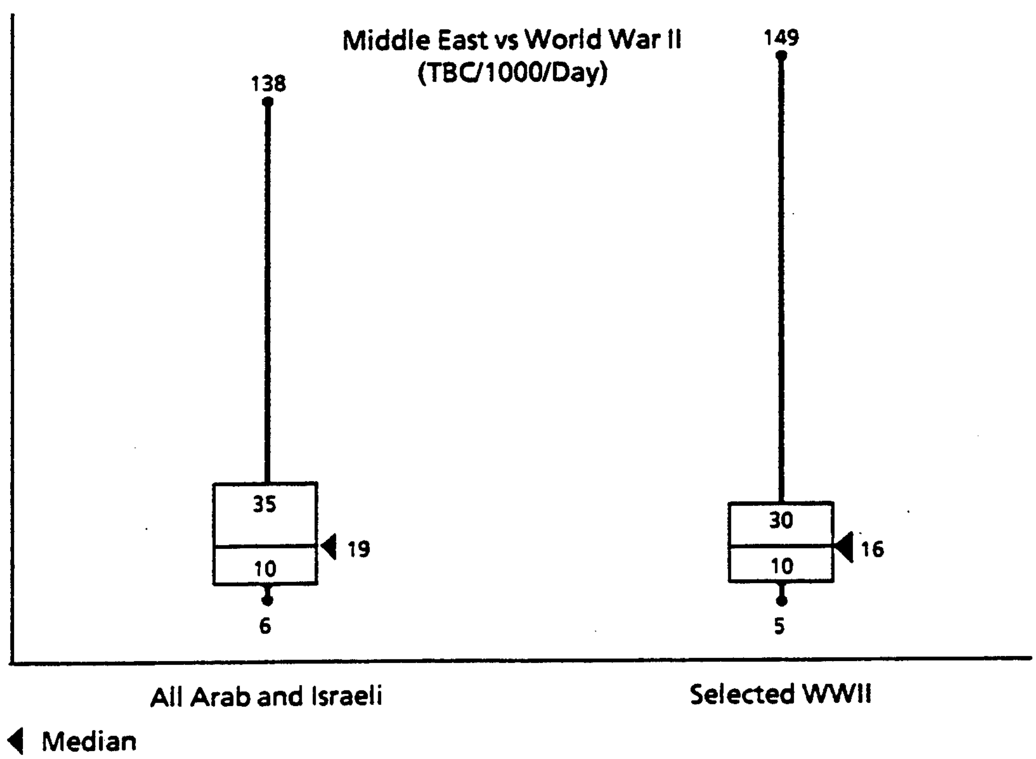


FIG. G-3. BOX PLOTS OF SINGLE-DIVISION/SINGLE-DAY CASUALTY RATES

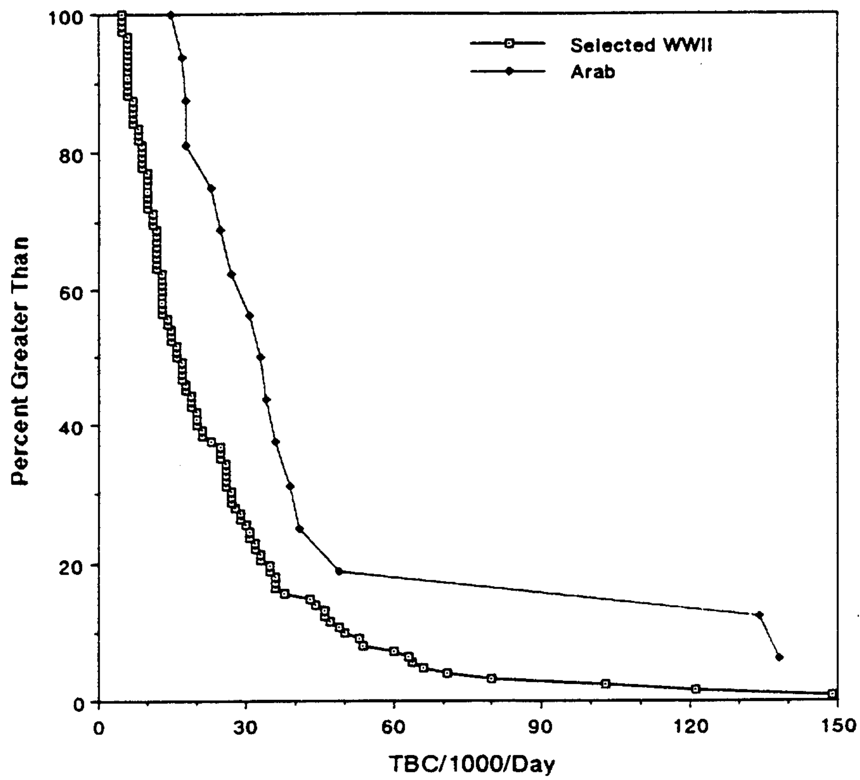


FIG. G-4. SURVIVOR CURVES OF ARAB-ONLY VERSUS WORLD WAR II RATES

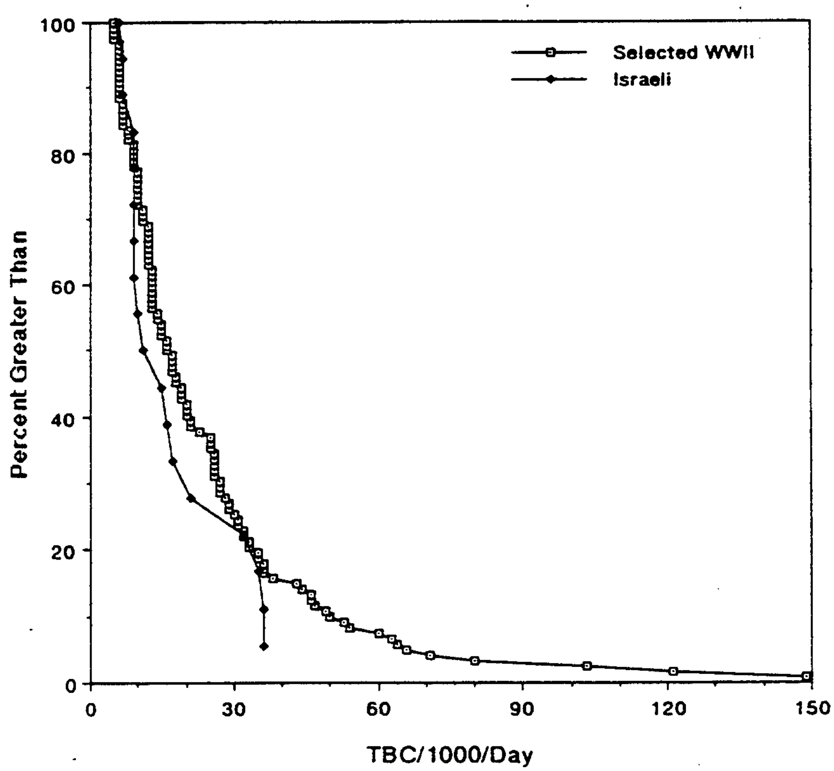


FIG. G-5. SURVIVOR CURVES OF ISRAELI-ONLY VERSUS WORLD WAR II RATES

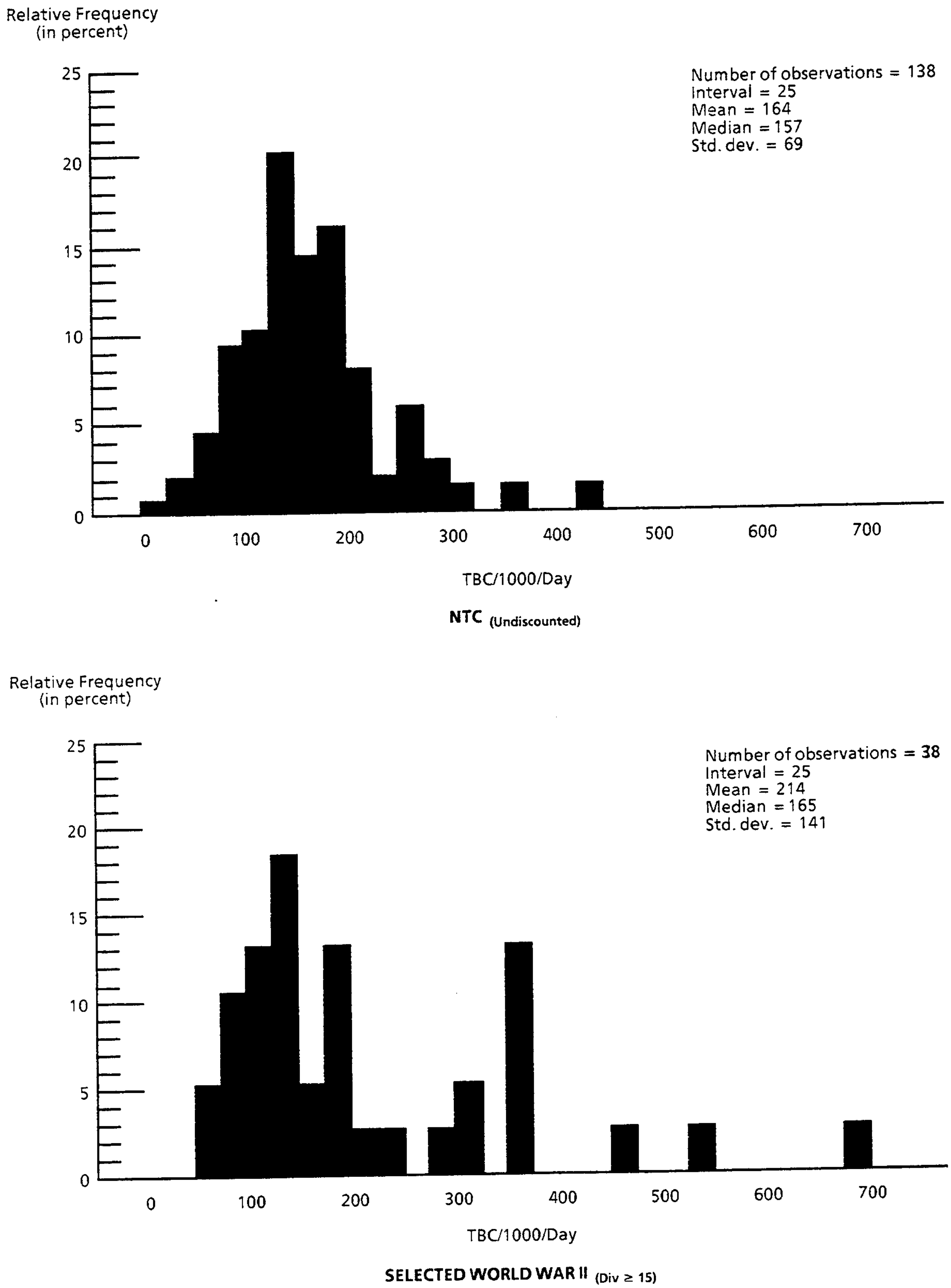


FIG. G-6. HISTOGRAMS OF BATTALION CASUALTY RATES FOR NTC AND WORLD WAR II (Div ≥ 15)

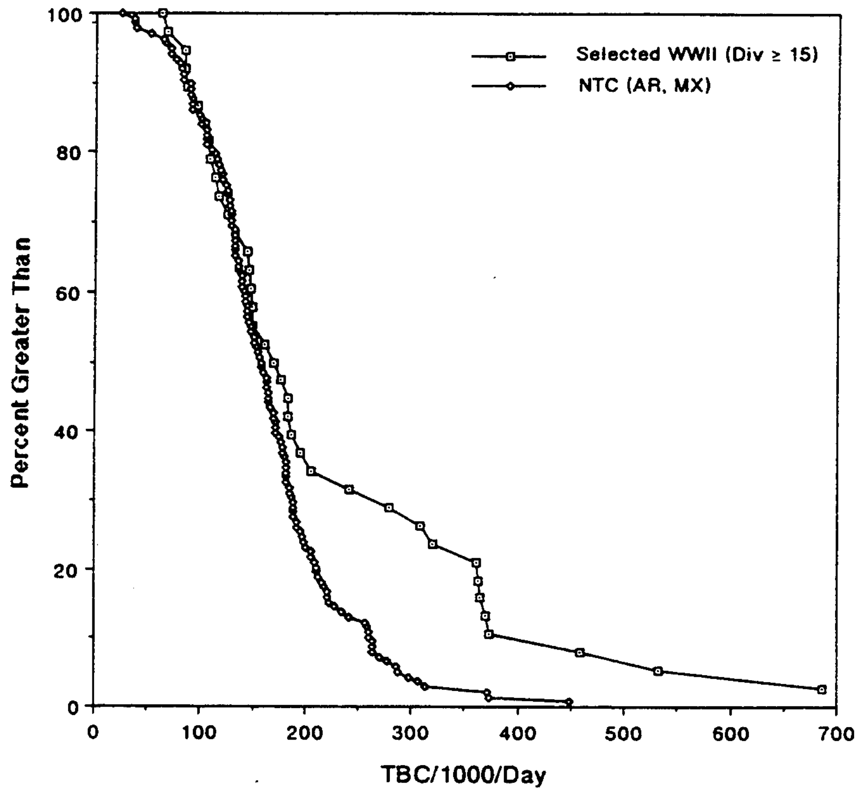


FIG. G-7. SURVIVOR CURVES OF NTC VERSUS WORLD WAR II (Div ≥ 15)

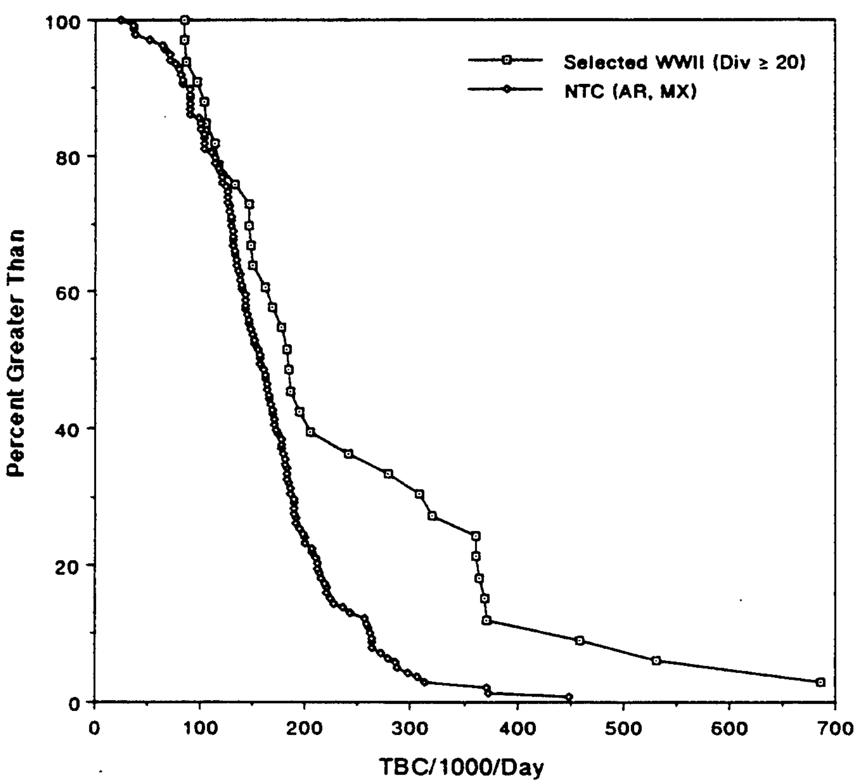


FIG. G-8. SURVIVOR CURVES OF NTC VERSUS WORLD WAR II (Div ≥ 20)

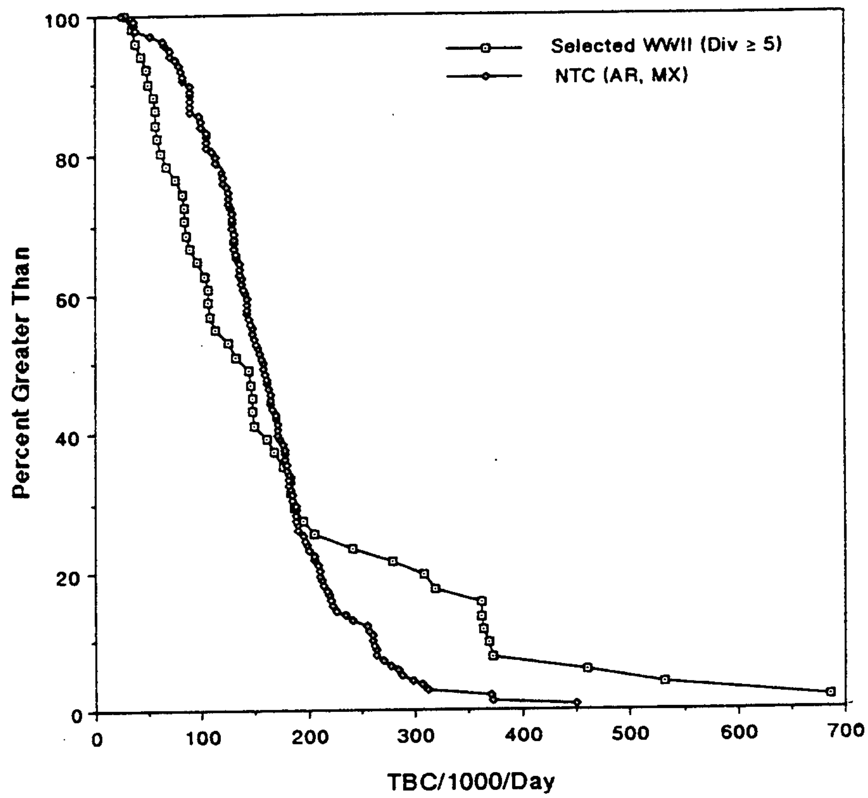


FIG. G-9. SURVIVOR CURVES OF NTC VERSUS WORLD WAR II (Div ≥ 5)

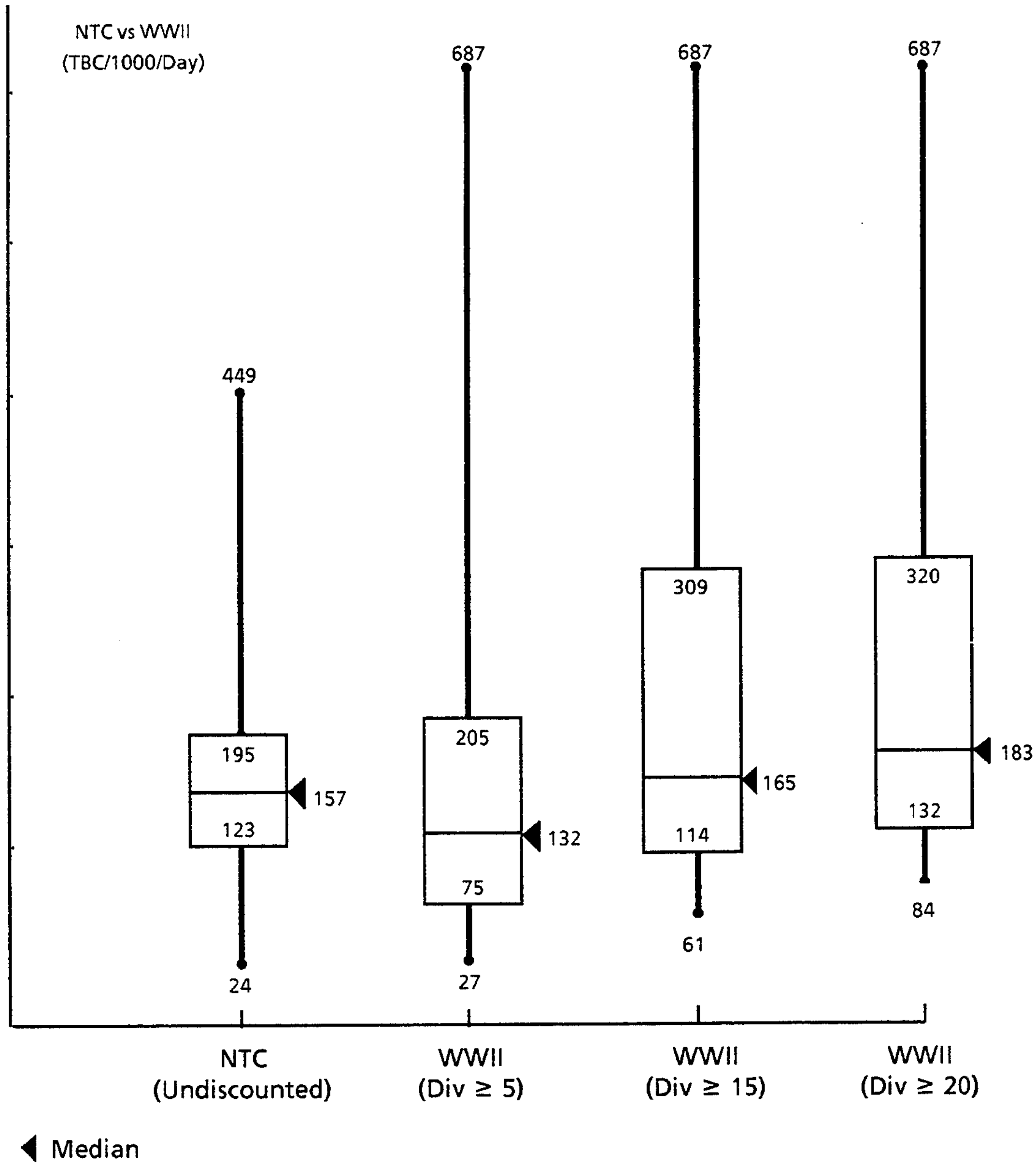


FIG. G-10. BOX PLOTS OF NTC AND WORLD WAR II BATTALION CASUALTY RATES