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OPERATIONAL RESEARCH DIVISION

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A SURVEY OF EXPERIMENTAL UAV SQUADRONS IN EXERCISE ROBUST RAM AND OPERATION GRIZZLY

BY

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OTTAWA, CANADA

National Defence Défense nationale

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ABSTRACT

A Concept Development and Experimentation (CD&E) programme at the Canadian Forces Experimentation Centre (CFEC) is currently investigating Uninhabited Aerial Vehicles (UAV) as components in an Integrated Intelligence, Surveillance, and Reconnaissance Architecture (IISRA). The operational requirement for UAVs is to contribute to the information and intelligence capabilities specified by the Canadian Forces' Strategy 2020. Potentially, the UAV offers the attractive qualities of ease of deployment and broad military capabilities. Experimental UAV squadrons were assembled in order to support Exercise Robust Ram and OPERATION GRIZZLY. This research note describes the analysis of data collected in an improvised questionnaire completed by members of experimental UAV squadrons. The Experimentation Operational Research Team (EXORT) was tasked to analyse the surveys through their role as experiment designers and evaluators at CFEC. An important result is the null response rate, which supports the recommendation that future questionnaires receive a more attention at the design and collection phases. However, more interesting are the useful insights inferred within the survey results' margin of error. Using a content-based analysis method, the experimental UAV squadrons indicated, in many different ways, dissatisfaction with the speed and reliability of the Intelligence, Surveillance and Reconnaissance network. These problems were compounded by the respondents' misapprehension of the chain of command and an impractical preference for live streaming video. From these results, it is concluded that an IISRA must be a clear organisational structure capable of supporting the timely transformation of the most useful UAV data into readily available information and, whenever possible, intelligence. Specific recommendations indicate practical steps to realise of the full potential of UAV operations within an IISRA and to progress toward the goals of Strategy 2020.

RESUME

Le Centre d'expérimentation des Forces canadiennes mène actuellement un programme d'élaboration de concepts et d'expérimentation (ECE) visant à examiner la possibilité d'inclure le véhicule aérien télé-piloté (VAT) dans une architecture intégrée de renseignement, de surveillance et de reconnaissance. Les besoins opérationnels des VAT doivent s'ajouter aux capacités d'information et de renseignement spécifiées par les Forces canadiennes dans la Stratégie 2020. Les VAT pourraient offrir de précieux avantages, tels qu'une facilité de déploiement et un grand potentiel militaire. Des escadrons de VAT expérimentaux ont été mis sur pied afin d'appuyer l'exercice Robust Ram et l'Opération Grizzly. La présente note de recherche décrit l'analyse des données recueillies grâce à un questionnaire improvisé qui a été remis au personnel de ces escadrons. En tant que concepteurs et évaluateurs d'expérimentation au CEFC, les membres de l'Équipe de recherche opérationnelle expérimentale ont été chargés d'analyser les réponses au sondage. Un résultat important en est la fréquence de réponses nulles, ce qui appuie les recommandations stipulant que la conception et la collecte des prochains questionnaires devront nécessiter une attention plus soutenue. Plus intéressants sont les renseignements révélés à l'intérieur de la marge d'erreur des réponses. Utilisant une methodologie basée sur le contenu, les membres des escadrons de VAT expérimentaux ont exprimé de nombreuses façons différentes leur insatisfaction à l'égard du manque de rapidité et de fiabilité du réseau de renseignement, de surveillance et de reconnaissance. Ces difficultés étaient aggravées par la fausse conception qu'avaient les répondants de la voie hiérarchique et par leur préférence pour une méthode peu pratique : la séquence vidéo en direct. Ces résultats nous permettent de conclure que l'architecture intégrée de renseignement, de surveillance et de reconnaissance doit être une structure organisationnelle claire, capable d'assurer la transformation rapide des données les plus utiles touchant les VAT en information ou, si possible, en renseignements rapidement utilisables. Des recommandations particulières indiquent des étapes pratique visant à tirer le plein potentiel des opérations faisant appel aux VAT dans le cadre de cette architecture intégrée et à atteindre les objectifs de la Stratégie 2020.

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LIST OF ABBREVIATIONS/GLOSSARY

C2	Command and Control
CD&E	Concept Development and Experimentation
CF	Canadian Forces
CFEC	Canadian Forces Experimentation Centre
DND	Department of National Defence
EXORT	Experimentation Operational Research Team
G8	Group of Eight industrialized countries (Canada, France, Germany, Italy, Russia, Spain, United Kingdom, United States of America)
IISRA	Integrated Intelligence, Surveillance, and Reconnaissance Architecture
ISR	Intelligence, Surveillance, and Reconnaissance
Stove-piped	An ISR architecture in which lines of communication are kept separate and remain in a single element of a larger organization.
UAV	Unmanned Aerial Vehicle (also Uninhabited Aerial Vehicle to emphasize that necessity for manning the ground-based support).

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A SURVEY OF EXPERIMENTAL UAV SQUADRONS IN EXERCISE ROBUST RAM AND OPERATION GRIZZLY

I - INTRODUCTION

1. The aim of this research note is to present an analysis of a questionnaire that was given to members of experimental Uninhabited Aerial Vehicle (UAV) squadrons at Exercise Robust Ram and OPERATION GRIZZLY. Specific responses to the questionnaire are detailed in the interim report (see Reference [1]), where they are discussed in the context of the whole experimental effort. The focus of this research note is to document the methodology and summarise results. The questionnaire is shown in Annex A, and details of the quantitative survey results are presented in Annexes B and C.

2. The Deputy Chief of Defence Staff, in cooperation with the Vice Chief of Defence Staff and the Assistant Deputy Minister of Science and Technology, authorized the creation of the Canadian Forces Experimentation Centre (see Ref. [2]). It is from this mandate that CFEC performs Concept Development and Experimentation (CD&E) related to UAV employment. Due to its responsibility to provide experiment design and evaluation support to CFEC, the Experimentation Operational Research Team (EXORT) received its task to analyse the surveys.

3. This research note contributes to the Information and Intelligence project of the Canadian Forces Joint CD&E Plan Pegasus given in Reference [3]. The particular conceptual hierarchy into which this work belongs is given a detailed presentation in Reference [3], but may be summarized (from highest to lowest) as follows:

a. Capstone Concept. Strategy 2020 (Reference [4]) sets the requirement for the Canadian Forces to be capable of world-wide coalition operations;

b. Integrating Concept. Information and Intelligence (I2) is one of the eight capability areas of the Canadian Joint Task List (CJTL), which is given in Reference [5];

c. Functional Concept. Integrated Intelligence, Surveillance, and Reconnaissance Architecture (IISRA), which is defined as:

(1) A joint and multi-level capability that combines a network of sensors, weapons, and databases with data fusion and decision support methods to optimize the collection and integration of commanders' information specifications or requirements;

(2) Intended to move the Canadian Forces away from a stove-piped ISR architecture toward joint planning, joint Command and Control (C2), and integration of data and information management; and

(3) Improved effectiveness in collecting and analyzing ISR data to provide better knowledge for decisions regarding the utilization of military and non-military capabilities.

d. Employment Concept. The Uninhabited Aerial Vehicle (UAV) is investigated as a possible means to alleviate critical ISR capability deficiencies identified by the CF.

4. The experimental UAV squadrons were assembled in order to support live UAV operations. The actual personnel included in the squadrons depended upon the subject (i.e. the event observed) of the experiment. Two events of interest are:

a. Exercise Robust Ram. The exercise was held April 2 to 22, 2002, in Suffield, Alberta. Some of the features of the exercise follow:

(1) Involved the First Canadian Mechanized Brigade (1 CMBG);

(2) Combined new Army weapons systems in live-fire, combat-team attack scenarios with the aim of improving mobility, firepower, survivability and security on the modern battlefield; and

(3) Participating Canadian Forces included three companies (with LAV III support), two artillery batteries, a Leopard C2 tank squadron, a Coyote squadron, combat engineers, combat service support and tactical helicopter support.

b. OPERATION GRIZZLY. The operation involved the Land Forces Western Area (LFWA), who were assigned the task of perimeter security for the Group of Eight (G8) Summit at Kananaskis, Alberta from June 26 to 28, 2002.

5. The experimental UAV squadrons performed similar tasks because they supported live operations in which the UAV was employed as an ISR asset. All squadrons included the personnel required to maintain the aerial vehicle and its sensors, to exercise command, to control the vehicle and sensors, and to perform a level-1 analysis of the data from the UAV. In this sense, there is a similarity of tasks. However, there was a difference in the contexts in which these tasks were performed; in one case the context was a Canadian military exercise (Ex Robust Ram) and in the other case the context was a real-world operation (OP GRIZZLY) that involved several government departments.

6. As indicated above, the experimental UAV squadrons were multi-disciplinary units. Individual squadron members had different levels of experience with UAV operations. For example, whereas some contractors had over ten years experience, some of the Canadian Forces members had no flight operations experience whatsoever. However, the distribution of experience, including the lack thereof, was similar in all squadrons. The survey probed units whose collective tasks were similar and whose collective experience – including the range of military rank – was comparable.

7. In order to seize the opportunities presented by Exercise Robust Ram and OPERATION GRIZZLY, there was limited time for detailed planning. In addition, CFEC was working up to (but had not reached) its Initial Operating Capability. Much of the effort, as a result, was improvised as required. The creation and application of the questionnaire provided a means to efficiently extract lessons learned.

II - THE METHOD

8. The intention of the questionnaire was to prompt participants to record their observations after each serial. The questionnaire (the full text is in Annex A) has four sections:

a. Personnel;

b. Communications;

c. Command and control; and

d. Concepts and doctrine.

9. The questions themselves are specifically related to the UAV squadrons' activities. Particular details of the responses to the questionnaire are discussed in Reference [1]; hence, they are not repeated in this research note. Instead, a general analysis of the responses is presented.

10. The analysis of a multiple-choice survey is straightforward, because the response set for each question is predefined (i.e. finite). However, the UAV questionnaire allowed the respondents to provide professional opinions and suggestions. Any analysis of an open-ended survey is difficult and time consuming; Reference [6] suggests that the best-suited method under such circumstances is content analysis.

11. This analysis is data-driven (i.e. observation-based), rather that theory-driven (i.e. expectation-based); therefore, this is an emergent content analysis (see Reference [7]). The method consisted of the following steps:

a. Create a database of all submitted forms;

b. For each question:

(1) Determine the random order in which to analyse the forms; and

(2) Read each response and decide whether to place it in an existing coding category or generate a new coding category.

12. The transferral of responses from their original text format to a compact representation in a database needed to be flexible enough to allow any response to belong to as many response-sets as required. For example, a respondent should be able to identify what type of available imagery was best suited for his task, as well as to express a preference for another type of imagery that was unavailable. This scheme makes sense for complementary responses, whereas contradictory answers (i.e. "yes" and "no") were rejected.

13. Reference [8] gives a flow chart representation of a generic content analysis. For the content analysis specific to this work, a similar, yet simplified, depiction is possible. Figure 1 shows the data reduction scheme in a flow chart. All responses are coded into the principal categories. Some responses that provide more details require ancillary categorisation. For example, if a "yes" or "no" response is all that is expected, then only the principle categories are required. However, if a response is expected to identify an object or activity, then the principal category records whether an object or activity was identified and the ancillary category records the identity of the object or activity.

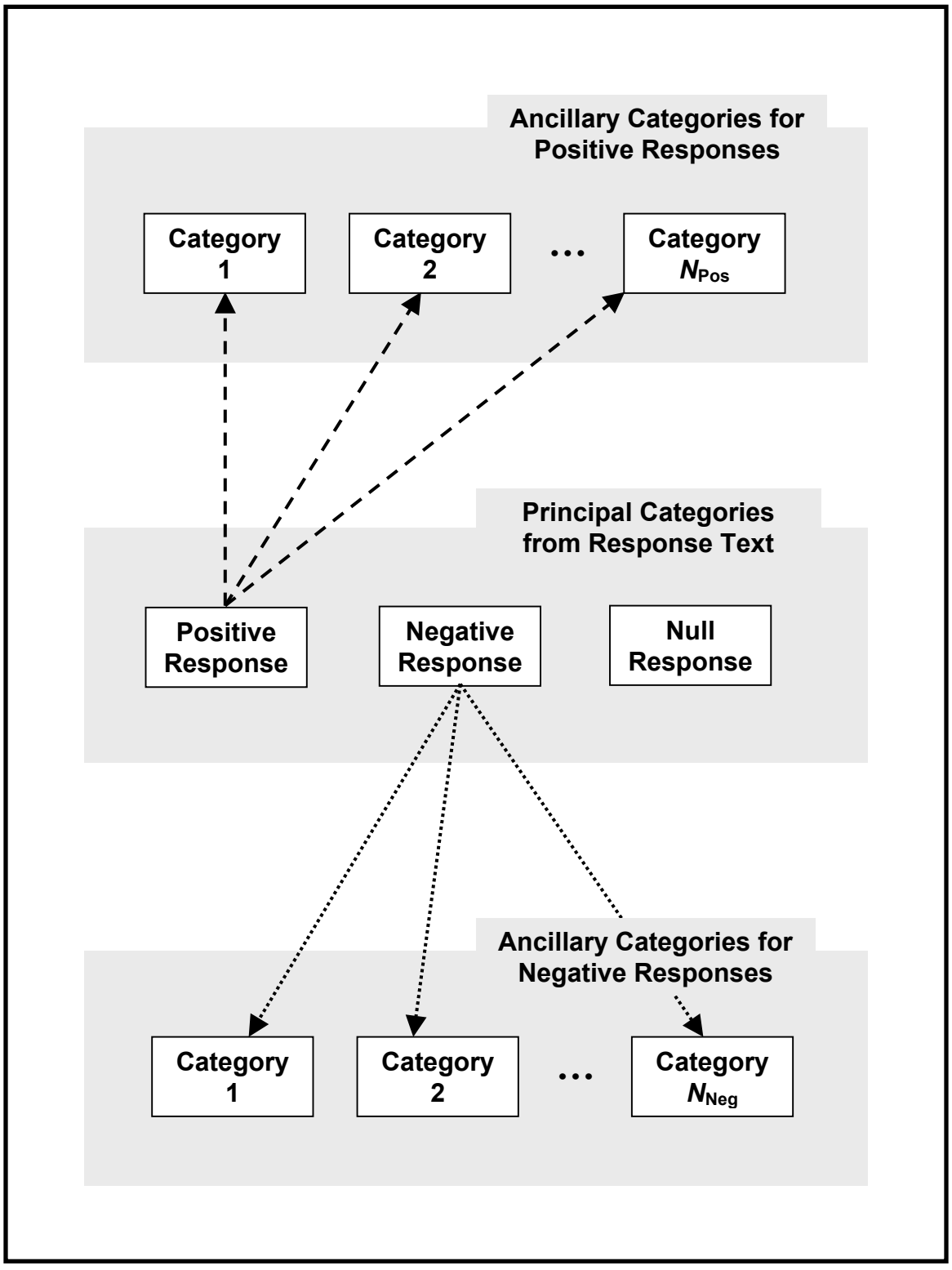

Figure 1: A Schematic of the Content Analysis

14. All responses are placed into one of the principal categories shown in Figure 1. Principal categories are defined as follows:

a. Positive Response. At its simplest, this is a "yes" response, but it also includes relevant information embedded in lengthy responses, which requires ancillary categorization;

b. Negative Response. This is either a "no" or a denial of the requested information; and

c. Null Response. This response yields no confirmation or denial of the requested information and some examples follow:

(1) A blank;

(2) A "not applicable" response;

(3) An unintelligible, self-contradictory, or ambiguous statement; or

(4) An unrelated statement (e.g. tangential commentary or anecdote).

15. The ancillary categories in Figure 1 are not necessary whenever the response is binary (e.g. "yes" or "no"), but when they are necessary, ancillary categories are generated for a positive response of the principal category. Ancillary categories may be generated from a negative response; however, such a case did not present itself in this work. As mentioned above, ancillary categories were generated after inspection of a random sample of responses. In other words, the categories emerge from the data itself; hence the name "emergent content analysis". The number of categories required is not determined until the entire collection of responses to each question is processed (indicated with *"*Category *N"* in Figure 1). If a response defies categorisation, then a new category is created. Categories may emerge at any time in the analysis.

16. Allowance for the continuous emergence of categories grants the flexibility needed for the analysis of open-ended questions. However, it also introduces an element of instability. Care must be exercised not to introduce either too many categories or too few categories. This was the most challenging aspect of the emergent content analysis. There are various methods (see References [6], [7], and [8]) suggested to control these tendencies. However, all methods require that multiple analysts process the same data, compare their categories, and then estimate errors. Neither the time nor the human resources were available to follow such a prescription. Rather, uncertainties associated with a single

analyst's pass through the data are considered below.

MARGIN OF ERROR

17. The uncertainty in the results is due to potential errors in the following:

a. The generation of (emergent) coding categories; and

b. The placement of a response into the proper category.

18. The uncertainty due to the generation of coding categories is manifested indirectly, because using the data to determine coding categories reduces the number of degrees of freedom remaining in the data. This is important if the data is used to calculate further statistical parameters (e.g. mean and variance) or tests of significance (see Reference [9]). In other words, the ability of the data to support further analysis is weakened. That is the cost of emergent content analysis. The actual loss in degrees of freedom is one less than the number N_C of categories created, because one category is required a priori, and $N_C - 1$ partitions emerge from the data.

19. The uncertainty due to the placement of a response into a specific coding category affects the number of responses in all categories. The underlying distribution of the response fractions in each coding category is assumed to be the multinomial distribution, which Reference [9] indicates is appropriate. The variance of the fraction of responses in each category can be estimated from the results. When the sample size N is less than thirty (i.e. $N \leq 30$), Annex D gives the required formula (equation D-1) from Reference [10].

III - RESULTS

20. The most important result is the null response rate, because it is a common feature of the responses to nearly every question (see paragraph 14.c for a definition of the null response). TABLE 1 shows that for Exercise Robust Ram the null response fraction was as high as 66% ± 8% (questions 2 and 9); and for OPERATION GRIZZLY the null response fraction was as high as 43% ± 19% (question 7).

21. In the next two subsections, the results for the two events of interest were analyzed separately. This segmentation is maintained for the purpose of presenting the highlights of the results. In the "Conclusions" section, the results are considered as a whole in order to provide a broader basis for recommendations.

TABLE 1

NULL RESPONSE FRACTIONS WITH 95% CONFIDENCE INTERVALS

	Null Response Fraction	
Question	**Ex Robust Ram**	**OP GRIZZLY**
1	38% ± 8%	7% ± 7%
2	66% ± 8%	15% ± 12%
3	33% ± 8%	18% ± 14%
4	40% ± 8%	22% ± 15%
5	54% ± 8%	29% ± 17%
6	33% ± 8%	7% ± 7%
7	43% ± 8%	43% ± 19%
8	38% ± 8%	7% ± 7%
9	66% ± 8%	39% ± 19%
10	31% ± 8%	22% ± 15%
11	53% ± 8%	18% ± 14%
12	44% ± 8%	29% ± 17%

Shaded results indicate that the 95% confidence interval extends above 50%.

EXERCISE ROBUST RAM

22. TABLE 2 gives the highlights of the content analysis of the 134 questionnaires that were completed during Exercise Robust Ram. There is a summary for each question. Whenever the percentages reported in TABLE 2 pertain to an ancillary category, the percentages apply only to the respondents who gave a positive response in the principal category (see Figure 1). In other words, many of the results in TABLE 2 do not apply to all of the respondents, but only to the principal category's subset of positive responses.

23. The content analysis did not explicitly depend upon the various skill-sets of the respondents. In other words, some respondents who were not qualified to answer some questions offered responses anyway, whereas some qualified personnel offered no response.

The skill-set dependence can be seen in Annex B where the results of the content analysis are separated into platform and personnel groups. The highlights in TABLE 2 must be considered within the context of that warning and the high null response fraction (see TABLE 1).

TABLE 2

HIGHLIGHTS OF THE EXERCISE ROBUST RAM SURVEY CONTENT ANALYSIS

Question	Highlight (ROBUST RAM)
1 Did you have sufficient personnel skills and resources to utilize the UAV information effectively?	52% ± 8% were satisfied with the personnel skills and resources
2 Any personnel suggestions?	22% ± 7% made personnel suggestions, of which 35% ± 17% suggested more/better image analysts, 38% ± 17% more/better IT support, and 27% ± 16% more/better mission planners
3 Were you able to talk to everyone you needed regarding the UAV mission?	43% ± 8% were satisfied with communications between personnel
4 Did you receive the UAV information promptly?	47% ± 8% received UAV information promptly
5 What could have been done to make the UAV comm. structure more effective?	36% ± 8% gave suggestions to improve the communication structure, and of those suggestions the most common (34% ± 12%) was to increase the network speed and/or bandwidth
6 What did you do with the UAV information you received?	Of the 64% ± 8% who stated that they did something with the information, only 5% ± 3% made immediate use of it, and the remainder recorded or retransmitted (to another person) the information

Question	Highlight (ROBUST RAM)
7 Did you receive a tasking involving UAV imagery? What was it?	51% ± 8% acknowledged receiving a task, of which 88% ± 6% were directly related to ISR
8 Describe your chain of command related to the UAV mission.	Of the 58% ± 8% who described a chain of command, 21% ± 9% identified one level, 38% ± 11% two levels, 35% ± 11% three levels, and the remainder identified four or more levels
9 How did you interact with the ISR Comd?	Only 12% ± 5% described the means by which they interacted with ISR command, and of those descriptions most indicated e-mail and voice interactions
10 Were the UAV airspace arrangements flexible enough to permit effective use of the UAV?	67% ± 8% thought that the airspace arrangements were flexible enough
11 Were you satisfied with the timeliness of the UAV product?	39% ± 8% were satisfied with the timeliness of the UAV product (i.e. imagery)
12 What type of product was best suited for your tasks (still, motion or live streaming video imagery)? Would you have preferred another type of imagery?	Of the 33% ± 8% who stated a preference, 16% ± 10% preferred still imagery, 68% ± 13% preferred live (streaming) video, and the remainder would have preferred another type of imagery

OPERATION GRIZZLY

24. TABLE 3 gives the highlights of the content analysis of the 24 questionnaires that were completed during OPERATION GRIZZLY. In addition to the caveats given in paragraphs 22 and 23, this survey encompasses a much smaller sample (24 questionnaires) than the same survey from Exercise Robust Ram (134 questionnaires).

TABLE 3

HIGHLIGHTS OF THE OPERATION GRIZZLY SURVEY CONTENT ANALYSIS

Question	Highlight (OP GRIZZLY)
1 Did you have sufficient personnel skills and resources to utilize the UAV information effectively?	71% ± 17% were satisfied with the personnel skills and resources
2 Any personnel suggestions?	Of the 75% ± 16% who had suggestions, the most common suggestion (33% ± 20%) was to use personnel experienced with multiple sensor operations
3 Were you able to talk to everyone you needed regarding the UAV mission?	57% ± 19% were satisfied with communications between personnel
4 Did you receive the UAV information promptly?	50% ± 19% received UAV information promptly
5 What could have been done to make the UAV comm. structure more effective?	Of the 68% ± 18% who made a suggestion, 29% ± 22% suggested a dedicated setup for the mission commander, 25% ± 21% suggested a simplified structure, 25% ± 21% suggested improvements to the network, and the remainder made other suggestions
6 What did you do with the UAV information you received?	Of the 82% ± 14% who stated that they did something with the information, 30% ± 17% made immediate use of it during the operation, and the remainder recorded or retransmitted the information

Question	Highlight (OP GRIZZLY)
7 Did you receive a tasking involving UAV imagery? What was it?	Of the 54% ± 19% who responded that they received a tasking, 47% ± 25% did not identify the mission, 42% ± 24% were given a reconnaissance task, and the remainder were tasked with surveillance and analysis
8 Describe your chain of command related to the UAV mission.	93% ± 7% described their chain of command: 32% ± 18% identified one level, 36% ± 19% two levels, and the remainder identified three or more levels
9 How did you interact with the ISR Comd?	Only 18% ± 14% gave a description of the means by which they communicated, and those descriptions were evenly split between voice radio and informal notes
10 Were the UAV airspace arrangements flexible enough to permit effect-ive use of the UAV?	43% ± 19% thought the airspace arrangements were flexible enough
11 Were you satisfied with the timeliness of the UAV product?	67% ± 18% were satisfied with the timeliness of the UAV product
12 What type of product was best suited for your tasks (still, motion or live streaming video im-agery)? Would you have preferred another type of imagery?	Of the 46% ± 19% who indicated a preference, all indicated that live (streaming) video was their preference

IV - CONCLUSIONS

25. The large null response rate indicates a loss of information. The questionnaire was generated and presented under demanding circumstances, because live field exercises or operations are difficult environments for the collection of survey data (especially compared to well-controlled laboratory experiments). Regardless of the cause of the null response, the analytical effort to salvage information from the survey was worthwhile; otherwise, the

quantitative information would have been entirely lost.

26. The differences between the UAV squadron at Ex Robust Ram and the UAV squadron at OP GRIZZLY are related to their reason for deployment. An exercise is an opportunity to develop competencies, whereas an operation presumes that the personnel are properly trained. The distinct differences between the Ex Robust Ram and OP GRIZZLY responses to the questionnaire are attributable to this essential difference in purpose.

PERSONNEL

27. At Exercise Robust Ram, approximately half the personnel thought that there were sufficient skills and resources to utilize the UAV information effectively, and nearly three-quarters of the personnel at OPERATION GRIZZLY thought the same. Considering that these are the first exercise and operation involving UAV squadrons, this is a positive result.

28. The most common suggestion from OPERATION GRIZZLY was to include personnel experienced with multiple sensor operations. Less than a quarter of the personnel at Ex Robust Ram offered suggestions, of which the more common were to improve Information Technology (IT) support and add more Image Analysts (IA). The underlying link is that a UAV squadron must be able to handle data and information quickly and reliably from raw sensor to refined intelligence product.

COMMUNICATIONS

29. Approximately half of the personnel at both events were satisfied with the following:

a. The ability to talk to everyone required regarding their UAV mission; and

b. The prompt receiving of UAV information.

This is an important result, because Command and Control of a future CF UAV squadron requires quick dissemination of information to all members, who may then make informed decisions regarding mission planning, execution, and support.

30. At Ex Robust Ram, the most common suggestion to improve the UAV communications structure was to improve the network speed (or bandwidth). At OP GRIZZLY, the same suggestion was made, but not as frequently as the proposal that the mission commander should have dedicated communications resources. This reiterates the speed and reliability issues mentioned in paragraph 29. The Command and Control of a UAV squadron would be reduced in effectiveness, if these issues were not resolved.

COMMAND AND CONTROL

31. The difference between observing a UAV squadron engaged in an exercise versus a real-world operation is most striking in the result that about one third of the personnel (who gave a response) at OP GRIZZLY made immediate use of the UAV information they received, whereas only one twentieth of the Ex Robust Ram personnel were similarly occupied.

32. In both events, approximately half of the personnel acknowledged receiving a task, and of those, the following had ISR-related tasks:

a. Nine out of ten in Ex Robust Ram; and

b. One half in OP GRIZZLY.

Given that the UAV was being evaluated as an ISR platform, this result indicates an appropriate tasking of the UAV squadron.

33. The variability of the descriptions of the chain of command may indicate either a misunderstanding of the intention of the question (a global description), or an obscure command structure. The former possibility is a flaw in the questionnaire, whereas the latter possibility is much more serious, because it would affect actual operations. All personnel ought to have a clear idea of the command structure in which they are included. Therefore, the flaws in the questionnaire must be addressed in order to ensure that the training of the personnel is appropriate.

34. The means of interaction with the ISR command was described by only one tenth at Ex Robust Ram and two tenths at OP GRIZZLY. The extent of the room for technological advancement of the CF is starkly illustrated in the response to this question. In particular, the means of communication at OP GRIZZLY were split between voice radio and informal notes.

CONCEPTS AND DOCTRINE

35. The flexibility of the UAV airspace arrangements permitted the effective use of the platform, according to two-thirds of Ex Robust Ram personnel and less than half of OP GRIZZLY personnel. Relative to the null response fraction, this result is indicative of a successful airspace plan.

36. The timeliness of the UAV imagery product satisfied two thirds of the OP GRIZZLY personnel, but less than half of Ex Robust Ram personnel. This is once again (see paragraphs 28 and 30) an indication of latency in the flow of data and information through the UAV squadrons. Nearly all of the squadron should be satisfied with the speed at which the UAV imagery is published.

37. A significant majority of the personnel in both events stated a preference for live streaming video. This result has serious implications on the design of a fast and reliable integrated ISR architecture. If it is the case that live streaming video is a military requirement, then a large amount of data must be carried on the ISR network. However, if live video is merely a personal preference and/or habit, then the UAV squadron would need training on how to focus on the data of greatest military value to the mission.

V - RECOMMENDATIONS

38. Questionnaires are difficult to construct. The goal is to ensure that there are questions that are relevant to respondents and to encourage the respondents to participate. This questionnaire clearly failed on this goal, as evidenced by the consistently large null response fraction. Therefore, it is recommended that the preparation of subsequent surveys should involve specialists in survey design and subject matter experts as reviewers.

UAV SQUADRON OPERATIONS

39. The recommendations pertaining specifically to development of a future UAV squadron are:

a. Provide the mission commander with dedicated communications support;

b. Ensure that all personnel have experience (or training) with multiple sensor operations;

c. A UAV squadron should have the qualified personnel to support quick and reliable ISR activities;

d. Train the squadron to react immediately to operationally relevant UAV data, information, and intelligence;

e. Continue to expand the role of UAV squadrons in ISR operations;

f. Ensure that the UAV squadron personnel have a common understanding of their chain of command;

g. Provide UAV squadrons with modern resources for internal (within the squadron) as well as external (beyond the squadron) communications;

h. Document and disseminate the method that produced successful airspace arrangements; and

i. Determine the military value of live streaming video to a UAV squadron engaged in ISR operations.

IISRA

40. The following recommendations are relevant to the design of an Integrated ISR Architecture (IISRA):

a. Govern the ISR network activity such that the most useful data and information has priority when operating under bandwidth restrictions;

b. Ensure that the chain of command and the function of positions within the IISRA is understood by all personnel; and

c. Provide for redundant means of communication (which was improvised at OP GRIZZLY) to prevent collapse due to a single point of failure.

VI - REFERENCES

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ANNEX A: THE QUESTIONNAIRE

Date		Serial			
Platform		Pilot		Sensor Op	
Launch Time		Recovery Time		Take Off Location	
Flight Duration		Flight Area		Routing	
Author of this report. (Name Rank SN, Unit)					
UAV Mission					
Weather Vis, clouds					
Imagery taken or seen. Targets found.					

<u>Personnel</u>. **1**. Did you have sufficient personnel skills and resources to utilize the UAV information effectively? **2**. Any personnel suggestions?	1. 2.

<u>Communications</u>. **3**. Were you able to talk to everyone you needed regarding the UAV mission? **4**. Did you receive the UAV information promptly? **5**. What could have been done to make the UAV comm. Structure more effective?	3. 4. 5.

<u>Command and Control.</u> **6**. What did you do with the UAV information you received? **7**. Did you receive a tasking involving UAV imagery? What was it? **8**. Describe your chain of command related to the UAV mission. **9**. How did you interact with the ISR Comd?	6. 7. 8. 9.

Concepts and Doctrine **10**. Were the UAV airspace arrangements flexible enough to permit effective use of the UAV?	10.
11. Were you satisfied with the timeliness of the UAV product?	11.
12. What type of product was best suited for your tasks (still, motion or live streaming video imagery)? Would you have preferred another type of imagery?	12.

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ANNEX B: SURVEY RESULTS FROM EXERCISE ROBUST RAM

1. The results of the content analysis are presented in standard bar charts, in which the length of the bar is proportional to the fraction (of responses) that fall into a particular response category. The following sections discuss each question in turn. The discussion includes the definition of the response categories and any question-specific details regarding the content analysis (see Annex C for OPERATION GRIZZLY results).

WARNING

2. The bar charts show the observed response fractions; however, the numbers reported in the text are the population proportion and the margin of error which are computed from the observed response fraction and the number of responses at the 95% confidence level (i.e. 19 times out of 20, the observed fraction shall fall within the margin of error about the population proportion). Therefore, the estimates of the population proportions do not necessarily sum to 100%, since they are merely indicating the centre about which the margin of error is applicable. See Annex D for further details.

B-I PERSONNEL SKILLS AND RESOURCES

3. Question 1 is:

> "Did you have sufficient personnel skills and resources to utilize the UAV information effectively?"

4. The principal categories are:

a. Yes;

b. No; and

c. Null.

5. Figure B-1 shows the bar chart for the content analysis of question 1. Given that this is the first plot of its type, there are some tags to help with the interpretation of the bar chart. The top bar includes all respondents, where as the subsequent bars are subsets of respondents. The subsets are defined as follows:

d. Platforms. The respondents may be subdivided according to which platform they were involved with:

(1) **Grdn:** Guardian;

(2) **I-G:** I-Gnat; and

(3) **Pnter:** Pointer.

e. Personnel Groups. The respondents may also be classified according to personnel, or skill, group:

(1) **Co:** Contractor (civilian);

(2) **G2:** Ground (or land) intelligence staff;

(3) **G3:** Ground (or land) operations staff;

(4) **IA:** Image Analyst;

(5) **LO:** Liaison Officer; and

(6) **SDC:** Scientific Data Collection (civilian).

6. The highlights from Figure B-1 are:

a. All. 52% ± 8% thought there were sufficient personnel skills and resources for effectively utilizing UAV information;

b. Platforms. The I-Gnat (I-G) personnel were most satisfied (59% ± 19% Yes) about the available skills and resources, the Guardian (Grdn) personnel were least satisfied (32% ± 20% No), and the Pointer (Pntr) personnel gave the highest Null response rate (43% ± 10%); and

c. Personnel Groups.

(1) The Contractors (Co) were most satisfied (93% ± 6% Yes), followed closely by the Liaison Officer (LO, 86% ± 12% Yes);

(2) The Image Analyst (IA) was least satisfied (43% ± 22% No), followed closely by the Ground Intelligence Staff (G2, 42% ± 34% No); and

(3) The Ground Operations staff (G3) had the highest Null response fraction (88% ± 10%), followed by the Scientific Data Collection (SDC) staff (80% ± 17%).

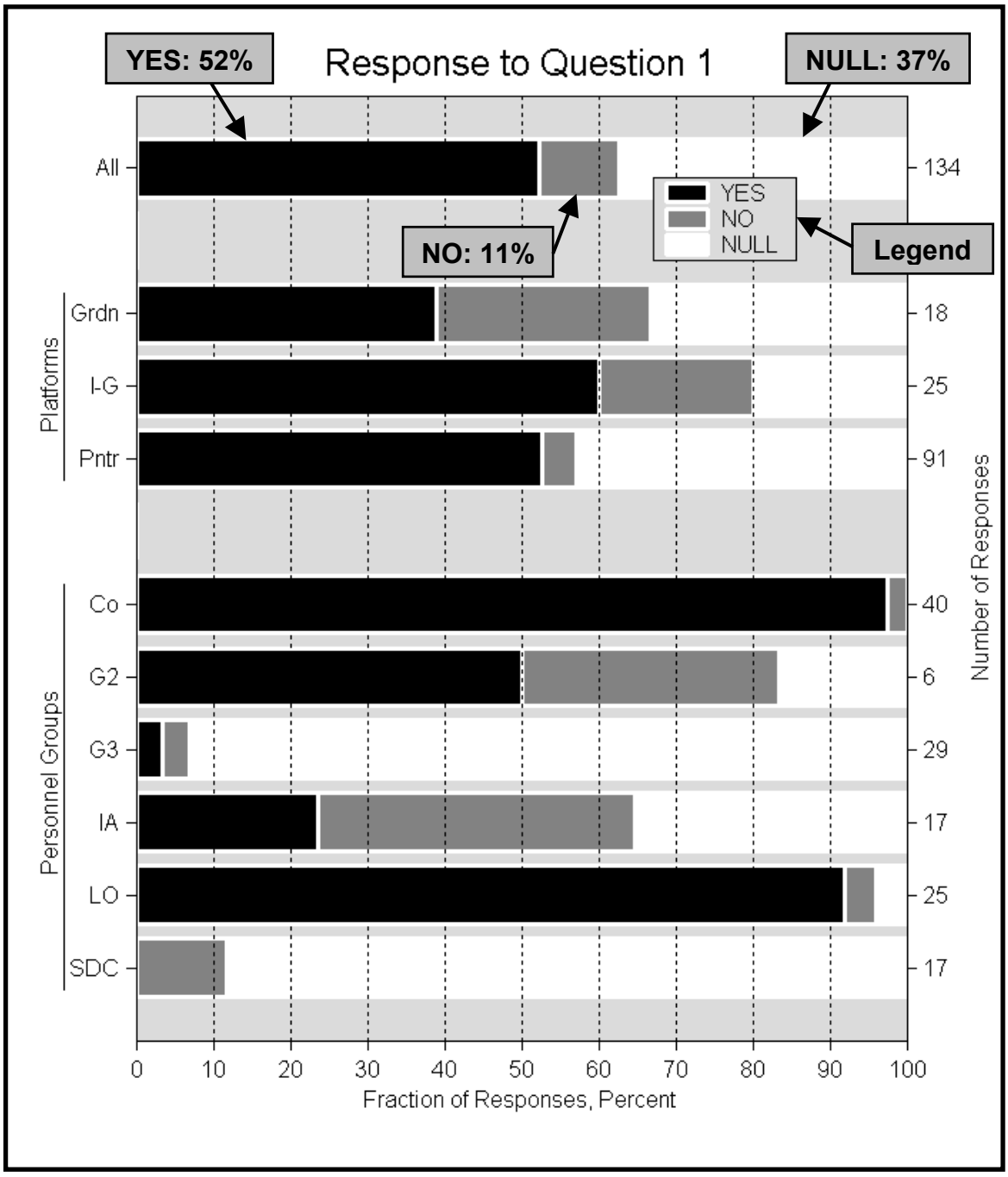

Figure B-1: Response to Question 1

B-II PERSONNEL SUGGESTIONS

7. Question 2 is:

"Any personnel suggestions?"

8. The principal response categories are plotted in Figure B-2. The highlights are:

a. All. 22% ± 7% had suggestions, but 66% ± 8% gave a null response;

b. Platforms. The yes-fractions of the Guardian (Grdn) and I-Gnat (I-G) respondents are about three times larger than the Pointer (Pntr) respondents; and

c. Personnel Groups. The Image Analyst (IA) made the most suggestions (76% ± 18% Yes), the Scientific Data Collection (SDC) personnel made the least (15% ± 14% Yes), and the Ground Operations (G3) personnel had a 94% ± 6% null response fraction.

9. From the "yes" responses of Figure B-2, the following personnel suggestion categories were generated:

a. More and/or better Image Analysts;

b. Better mission planners;

c. Fewer defence scientists;

d. Better soldiers; and

e. More Information Technology (IT) support and/or training.

10. The suggestions from question 2 are plotted in Figure B-3. The highlights are (the respondents were permitted to make one or more suggestions):

a. All. Most respondents (38% ± 17%) suggested "more IT support and/or training", followed by 35% ± 17% suggesting "more/better Image Analysts", and 27% ± 16% suggesting "better mission planners";

b. Platforms:

(1) 50% ± 41% of the Guardian (Grdn) staff made the "Image Analyst" suggestion, whereas 47% ± 27% of the Pointer (Pntr) staff made the "IT support" suggestion; and

(2) The I-Gnat (I-G) staff's suggestion fractions were closest to the fractions of the total (All) response; and

c. Personnel:

(1) The Image Analysts (IA) made the most suggestions (17), whereas the Ground Operations (G3) personnel made none;

(2) Most Contractors (Co) suggested "more IT support", and the most frequent IA suggestion (52% ± 24%) referred to themselves; and

(3) Other personnel groups gave too few suggestions to indicate a trend.

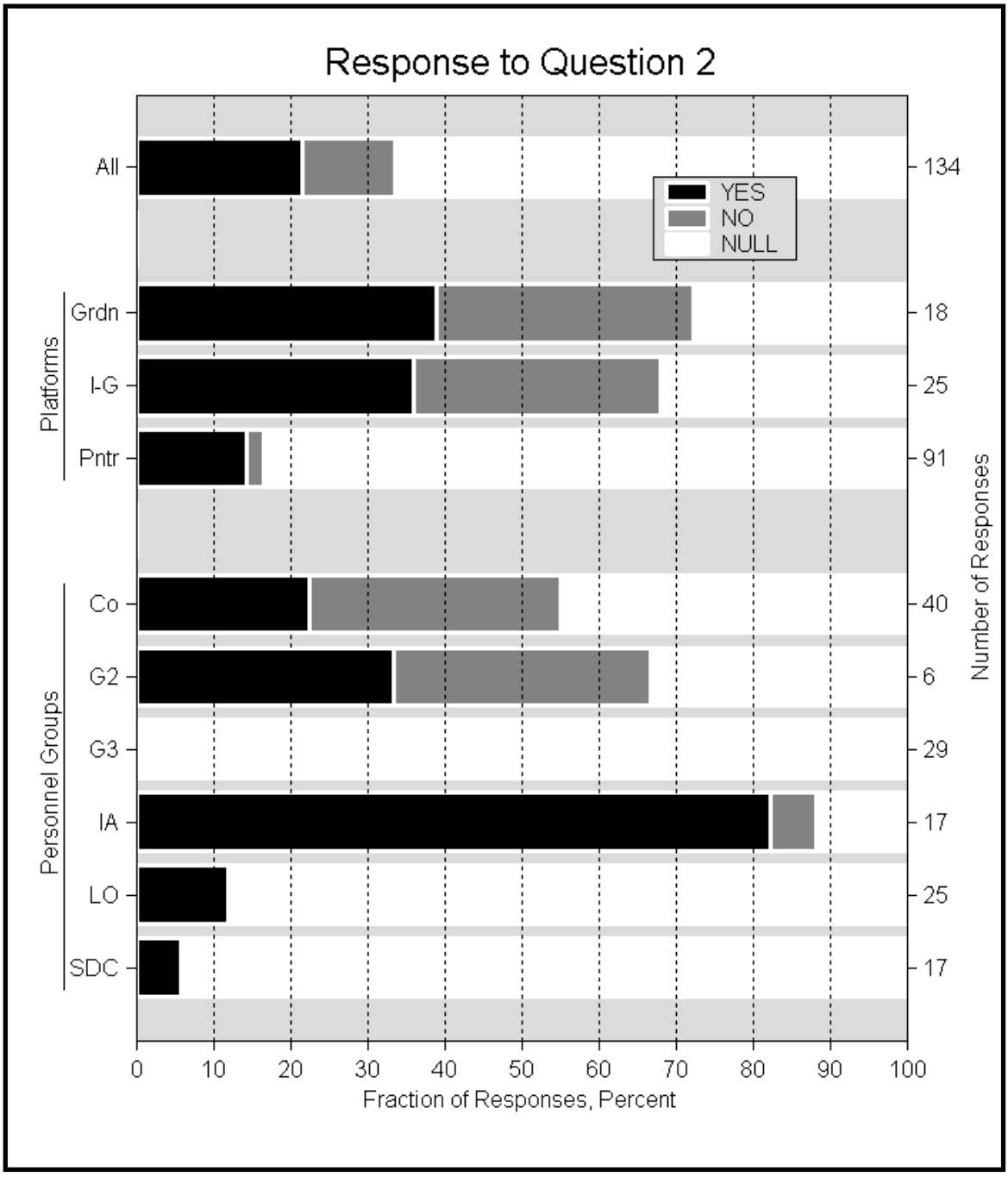

Figure B-2: Response to Question 2.

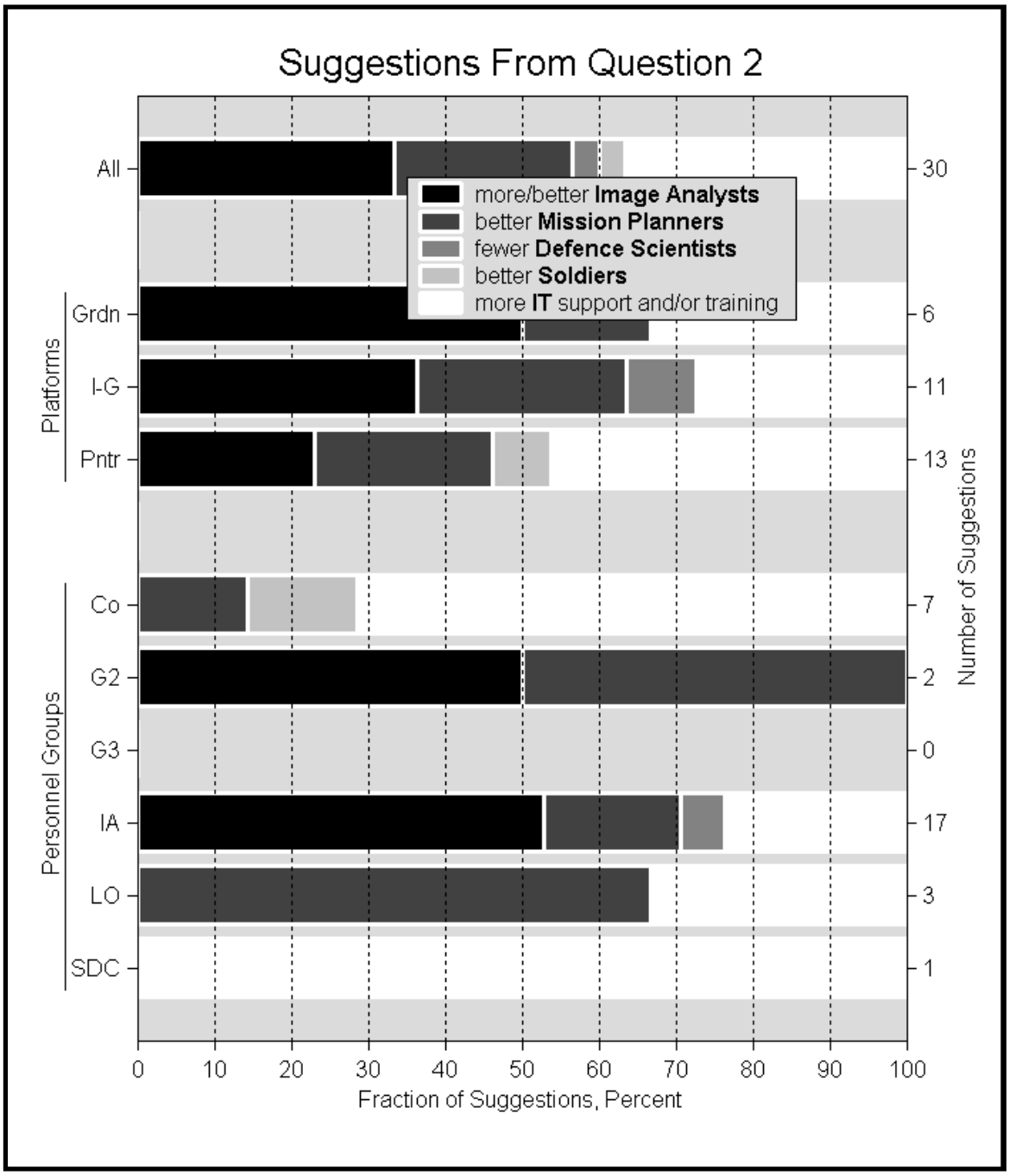

Figure B-3: Suggestions From Question 2

B-III NECESSARY COMMUNICATION

11. Question 3 is:

> "Were you able to talk to everyone you needed regarding the UAV mission?"

12. The principal categories (yes, no, and null) are plotted in Figure B-4. The highlights are:

a. All. 43% ± 8% said "yes" and 33% ± 8% gave a "null" response;

b. Platforms.

(1) The I-Gnat (I-G) and Pointer (Pntr) staff gave the highest "yes" (45% ± 19%) response fraction, but I-G gave the largest "no" (55% ± 19%)" response fraction; and

(2) The Pntr staff gave the highest "null" (44%) response fraction.

c. Personnel Groups:

(1) Contractors (Co) were most (82% ± 11% yes) satisfied with necessary communications, followed by Ground Intelligence (G2) personnel (59% ± 34% yes);

(2) Image Analysts (IA) were most dissatisfied (76% ± 18% no), followed by Scientific Data Collection (SDC) personnel (52% ± 23% no); and

(3) Liaison Officer (LO) and Ground Operations (G3) personnel had the highest the null response fractions, with 59% ± 19% and 55% ± 18% respectively.

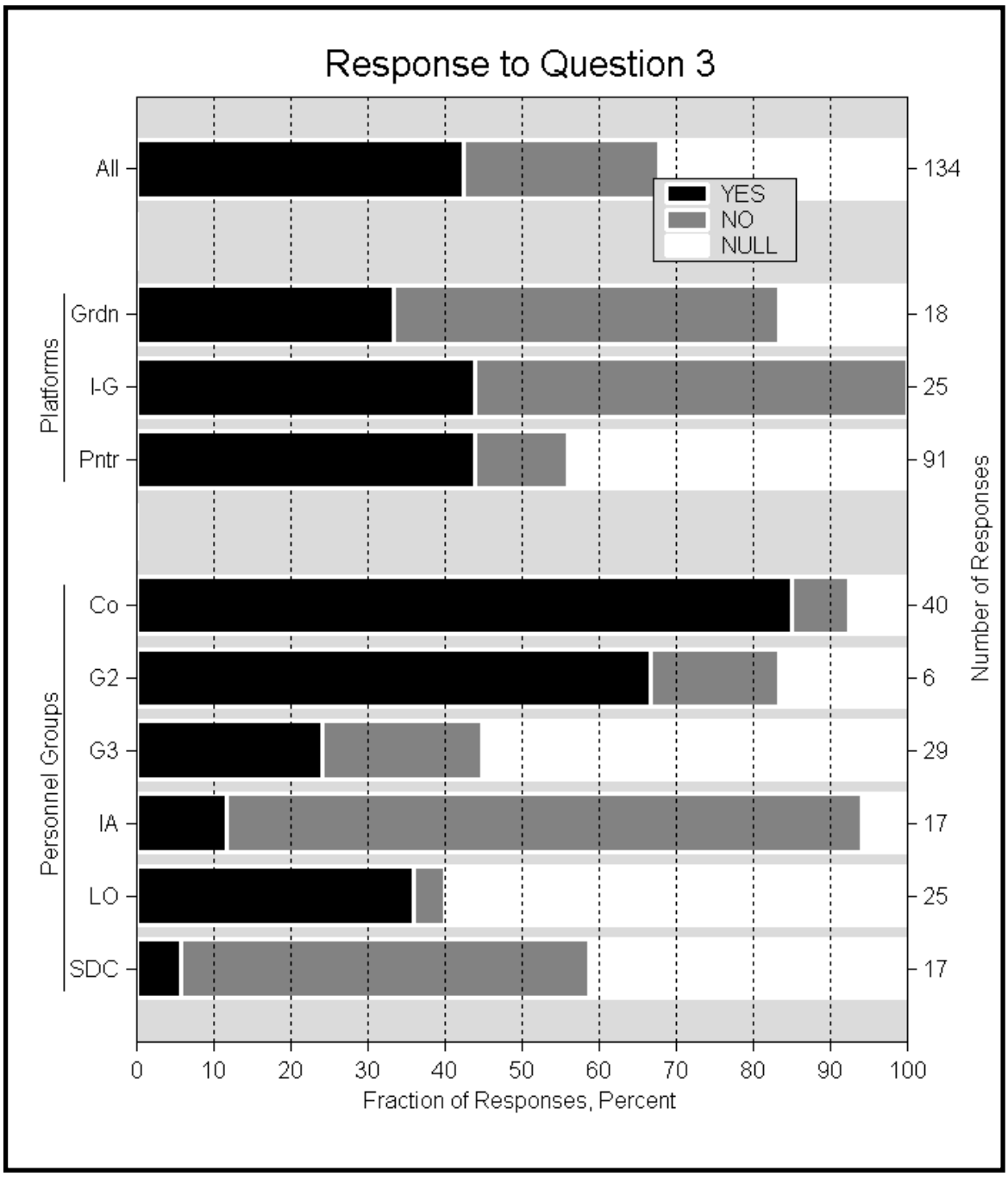

Figure B-4: Responses to Question 3

B-IV PROMPT INFORMATION

13. Question 4 is:

"Did you receive the UAV information promptly?"

14. The categories (yes, no, and null) are plotted in Figure B-5. The highlights are:

a. All. 47% ± 8% received information promply;

b. Platforms. The Guardian (Grdn) staff were most statisfied (59% ± 22% yes) with the promptness of communication, whereas I-Gnat (I-G) staff were most dissatisfied (35% ± 18% no); and

c. Personnel Groups:

(1) Contractors (Co) were most satisfied (89% ± 9% yes) with the promptness of communication;

(2) Image Analyst (IA) personnel were most dissatisfied (43% ± 22% no); and

(3) Scientific Data Collection (SDC) produced the highest null response fraction (76% ± 18%).

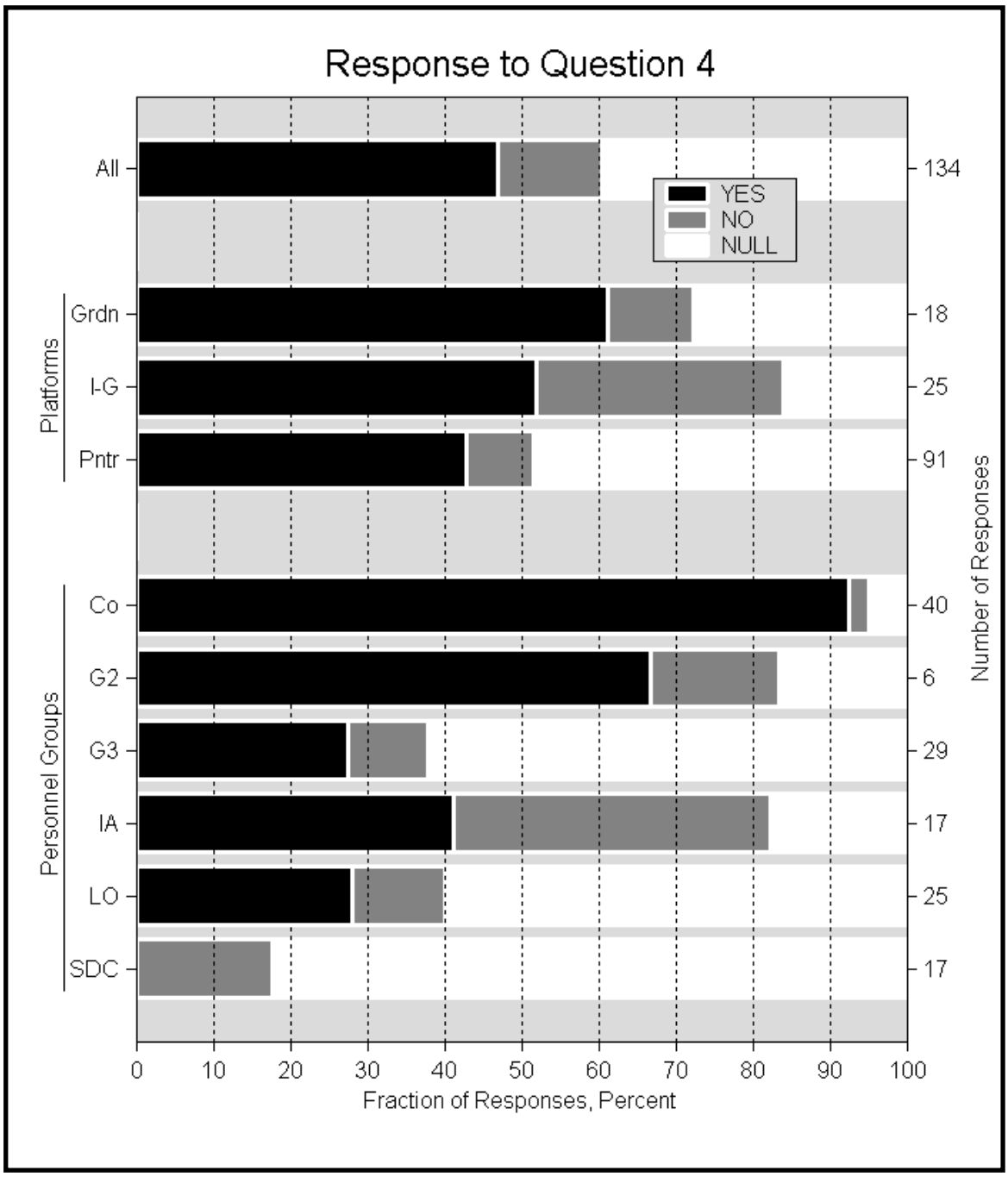

Figure B-5: Response to Question 4

B-V MORE EFFECTIVE COMMUNICATION

15. Question 5 is:

> "What could have been done to make the UAV comm. Structure more effective?"

16. The principal response categories are plotted in Figure B-6. The highlights are:

a. All. 36% ± 8% responded with a suggestion ("Yes"), and 12% ± 5% did not think anything could be done to make the communications structure more effective;

b. Platforms. The Guardian (Gdrn) staff had the largest fraction giving suggestions for improvement (68% ± 20%); the Pointer (Pntr) staff had the highest null response fraction (64% ± 10%); and

c. Personnel Groups. The Image Analysts (IA) had the highest suggestion fraction (66% ± 21% Yes), the Ground Intelligence (G2) personnel had the highest no-suggestion fraction (59% ± 34% No), and the Scientific Data Collection (SDC) personnel had the largest null response fraction (80% ± 17%).

17. From the "yes" responses of Figure B-6, the following ancillary categories of communications structure suggestions were generated:

a. Simplify communications structure;

b. Improve equipment and testing;

c. Better software;

d. Improve the network;

e. Reduce defence scientist interference;

f. Improve preparation

g. Have a common frequency for UAV and helicopters; and

h. Improve the link to and from the Image Analysts.

18. The suggestion categories from Question 5 are plotted in Figure B-7. The highlights are (the respondents were permitted to make one or more suggestions):

a. All. Most (34% ± 12%) suggested improvements to the network (its bandwidth and/or speed in particular), 22% ± 11% would improve the equipment and its testing, and 20% ± 10% would simplify the structure;

b. Platforms. The Pointer (Pntr) staff had the largest fraction (48% ± 21%) suggest an improved network, and the I-Gnat (I-G) had the largest fraction (44% ± 23%) suggest simplifications; and

c. Personnel Groups.

(1) The Contractors (Co) made the most number of suggestions (22);

(2) The Liaison Officer (LO) had the largest fraction (41% ± 32%) of suggestions for improvement of equipment and testing; and

(3) The Ground Operations (G3) personnel were the only group to suggest a common frequency for UAV and helicopters.

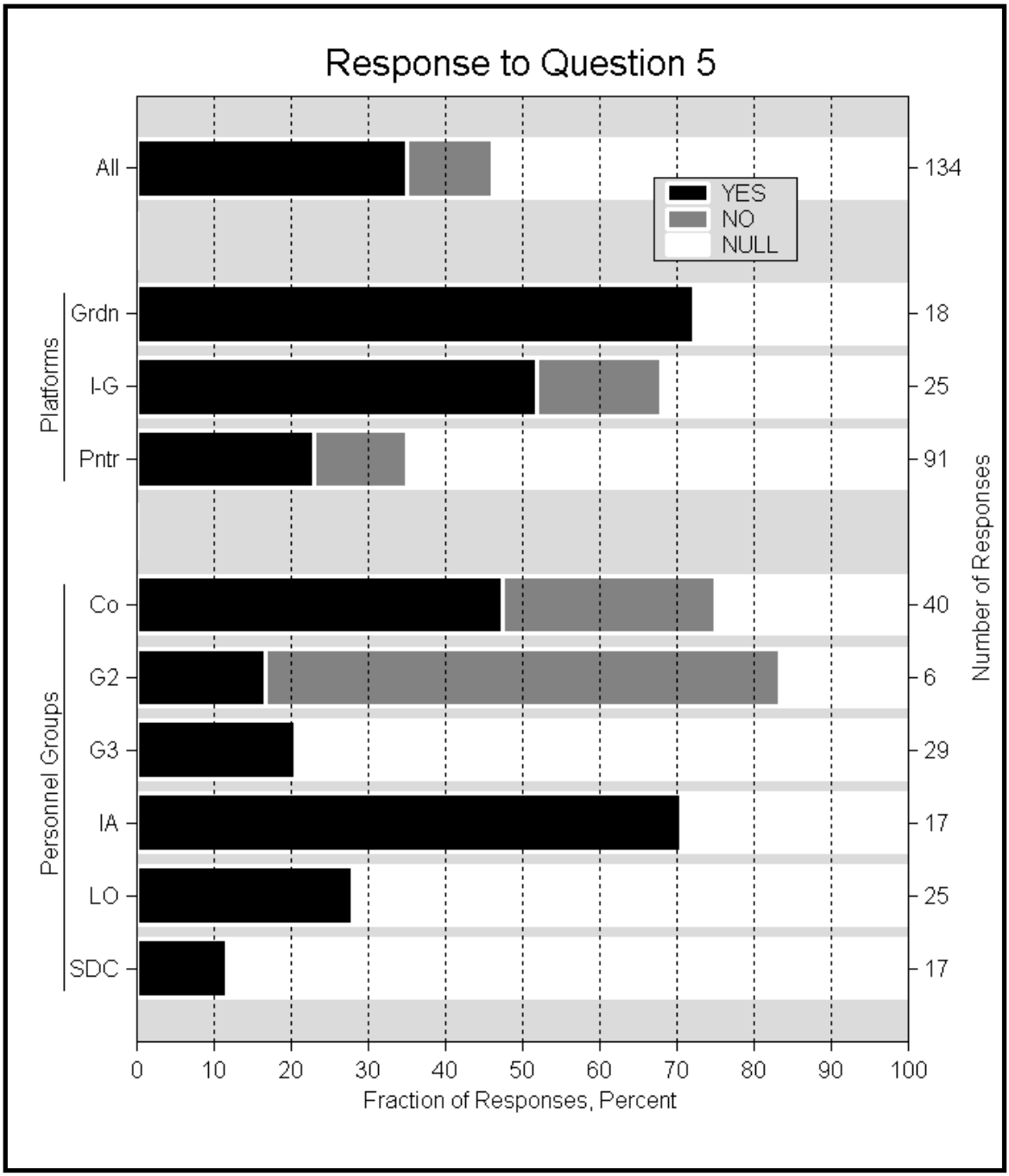

Figure B-6: Response to Question 5

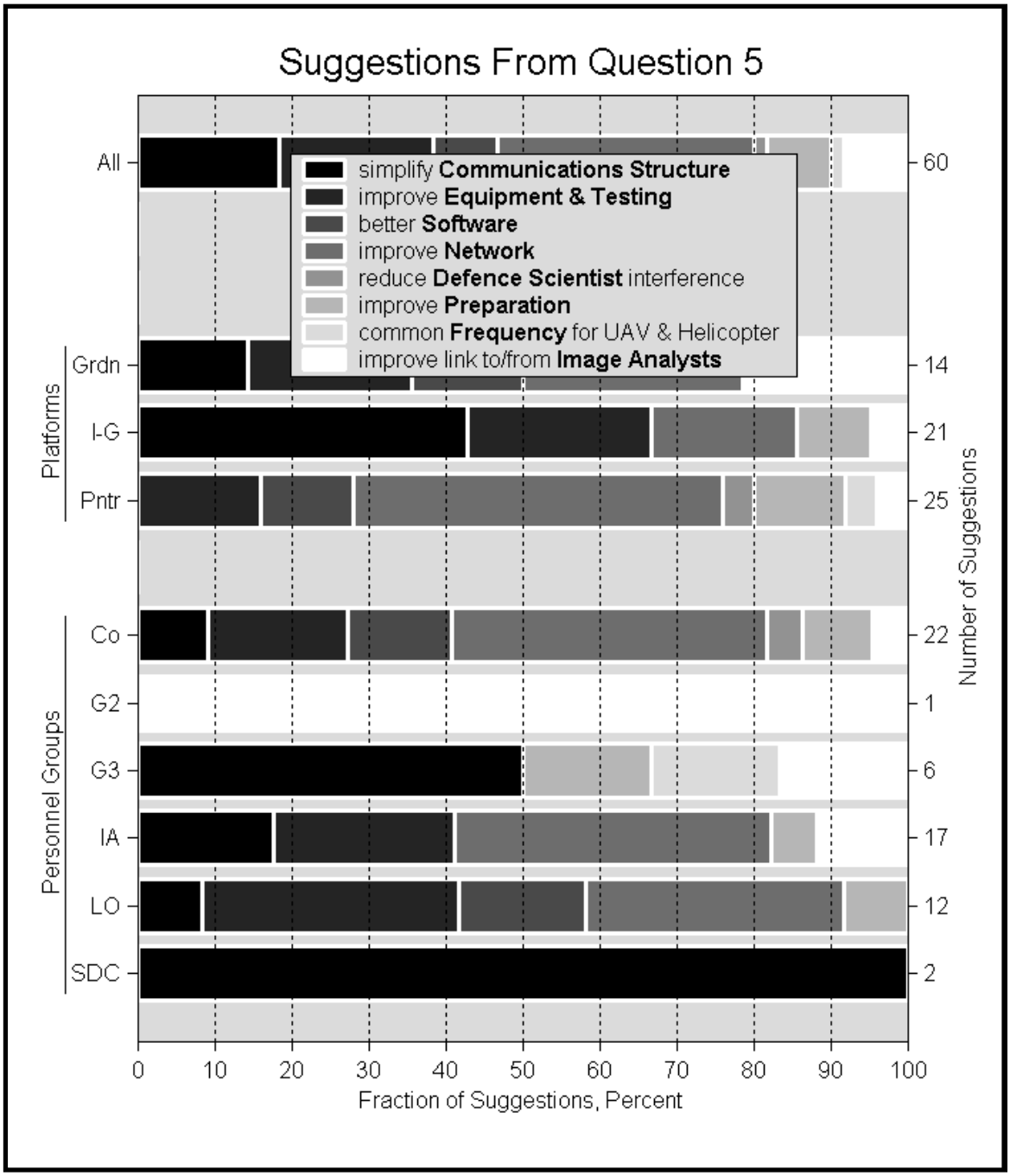

Figure B-7: Suggestions from Question 5

B-VI INFORMATION USE

19. Question 6 is:

"What did you do with the UAV information you received?"

20. The principal response categories are plotted in Figure B-8. The highlights are:

a. All. 64% ± 8% identified that they engaged in some activity with the UAV information they received; whereas 5% ± 3% reported that they did nothing;

b. Platforms. The Guardian (Gdrn) staff had the highest activity fraction (72% ± 19%), whereas the staff of both the I-Gnat (I-G) and the Pointer (Pntr) had similar activity fractions (62% ± 18% and 61% ± 10% respectively); and

c. Personnel Groups. The Contractor (Co) and Liaison Officer (LO) groups had the largest activity fractions (84% ± 11% and 79% ± 15% respectively), whereas the Scientific Data Collection (SDC) group had the lowest activity fraction (15% ± 14%).

21. From the "some activity" responses of Figure B-8, the following ancillary categories of activity (i.e. image data usage) were generated (the respondents were permitted to identify one or more activities):

a. Recorded image data;

b. Transmitted image data (during the serial);

c. Analyzed the image data;

d. Distributed image data after the serial; and

e. Acted upon the image data (during the serial).

22. The activity categories from Question 6 are plotted in Figure B-9. The highlights are:

a. All. The largest fraction (39% ± 9%) transmitted the image data, the second largest (37% ± 8%) recorded the image data, but only 5% ± 3% acted (immediately) upon the data;

b. Platforms. The Guardian (Grdn) staff had the largest fraction (40% ± 22%) engaged in analysis, 52% ± 20% of the I-Gnat (I-G) staff recorded the data, and 21% ± 9% of the Pointer (Pntr) staff distributed image data after the serial; and

c. Personnel Groups.

(1) The Contractor (Co) group had the largest data distribution fraction (34% ± 14%) and reported the largest number of activities (46);

(2) The Liaison Officer (LO) group had the largest data recording fraction (56% ± 16%);

(3) The Image Analysts (IA) group reported in 33% ± 20% of their activity they analyzed the image data; and

(4) The Ground Operations (G3) personnel had the greatest fraction (22% ± 19%) acting upon the image data.

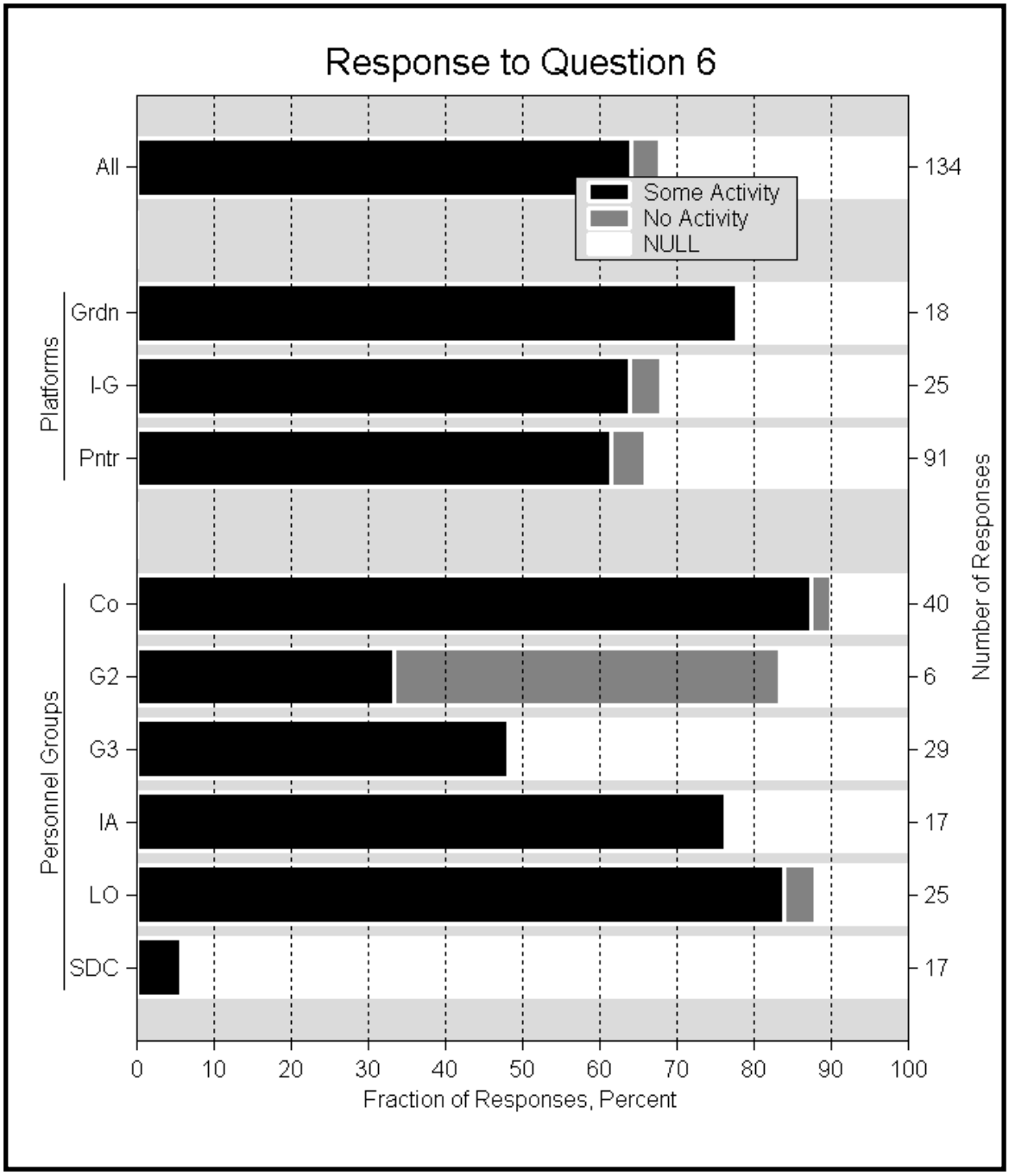

Figure B-8: Response to Question 6

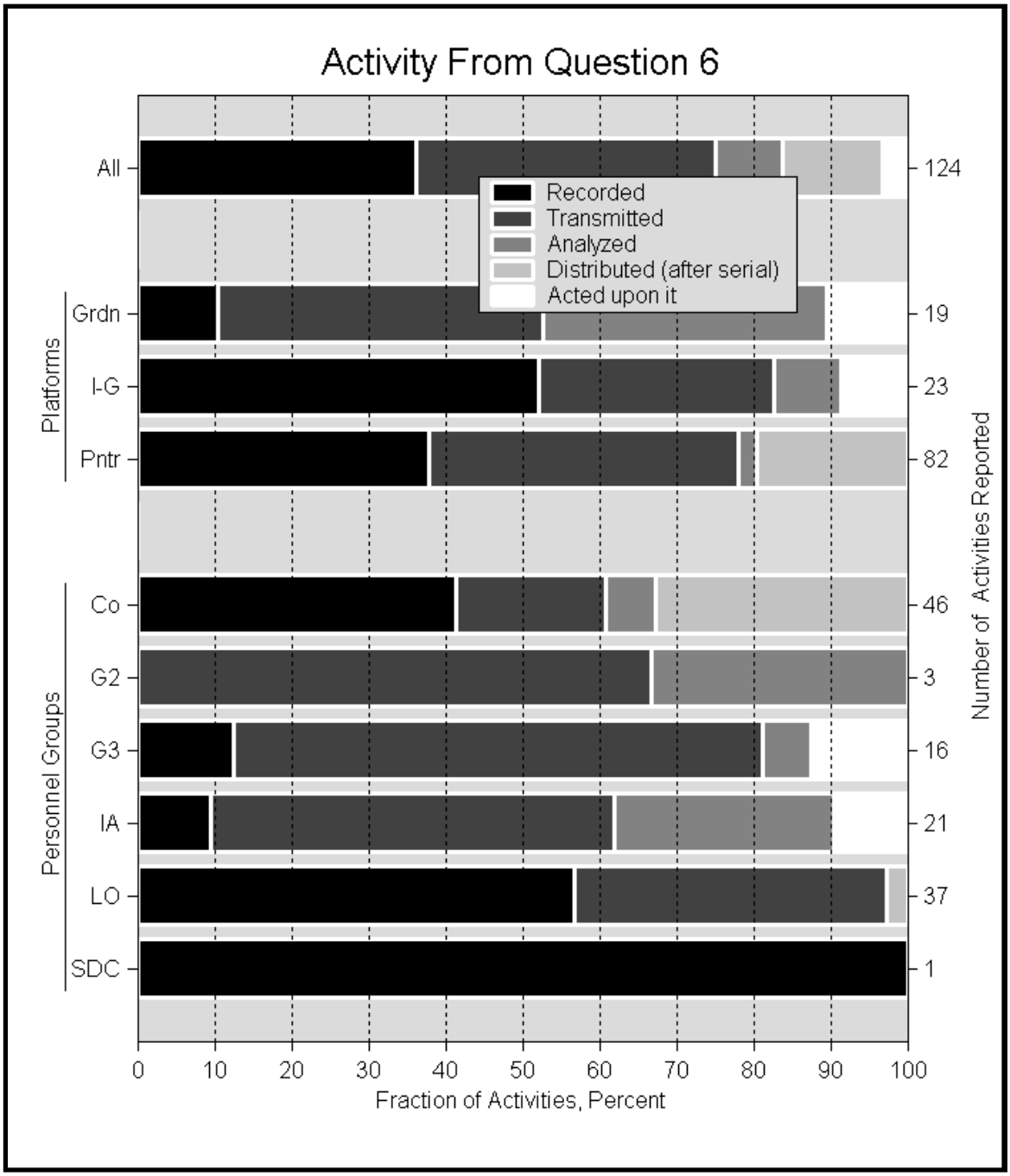

Figure B-9: Activities Identified in Question 6

B-VII UAV IMAGERY TASKS

23. Question 7 is:

> "Did you receive a tasking involving UAV imagery? What was it?"

24. The principal response categories are plotted in Figure B-10. The highlights are:

a. All. 51% ± 8% reported that they were assigned a task, 7% ± 4% reported that were not assigned a task, and the remainder is the null response fraction;

b. Platforms. For all three platforms, between 47% ± 10% and 59% ± 19% of respondents reported receiving a task.

c. Personnel Groups. The Contractor (Co) group reported the largest task assignment fraction (84% ± 11%), the Land Intelligence (G2) personnel reported no tasks, and the Land Operations (G3) personnel had the highest null response fraction (91% ± 9%).

25. From the "yes" responses of Figure B-10, the following ancillary categories of tasks were generated (the respondents were permitted to identify one or more tasks):

a. Reconnaissance, which included glimpse searches and quick looks at particular targets of interest;

b. Surveillance of one or more points, which includes persistent observation of one or more targets of interest;

c. Surveillance of one of more areas, which includes persistent patrol of one or more regions of interest;

d. Observer (passive);

e. Analysis; and

f. Unidentified task (the respondent reported that a task was assigned, but did not identify it).

26. The task categories from Question 7 are plotted in Figure B-11. The highlights are:

a. All. Nearly all of the reported tasks involved reconnaissance (35% ± 10%), point-surveillance (22% ± 9%), or area-surveillance (35 ± 10%);

b. Platforms. The Guardian (Grdn) staff reported only ISR tasks, the I-Gnat (I-G) staff reported the largest fraction (24% ± 19%) of observers, and the Pointer (Pntr) staff was the only platform to report an "analysis" tasking; and

c. Personnel Groups.

(1) Contractors (Co) reported the most tasks 43; and

(2) The Image Analyst (IA), and Liaison Officer (LO) personnel had similar fractions involved in reconnaissance and surveillance.

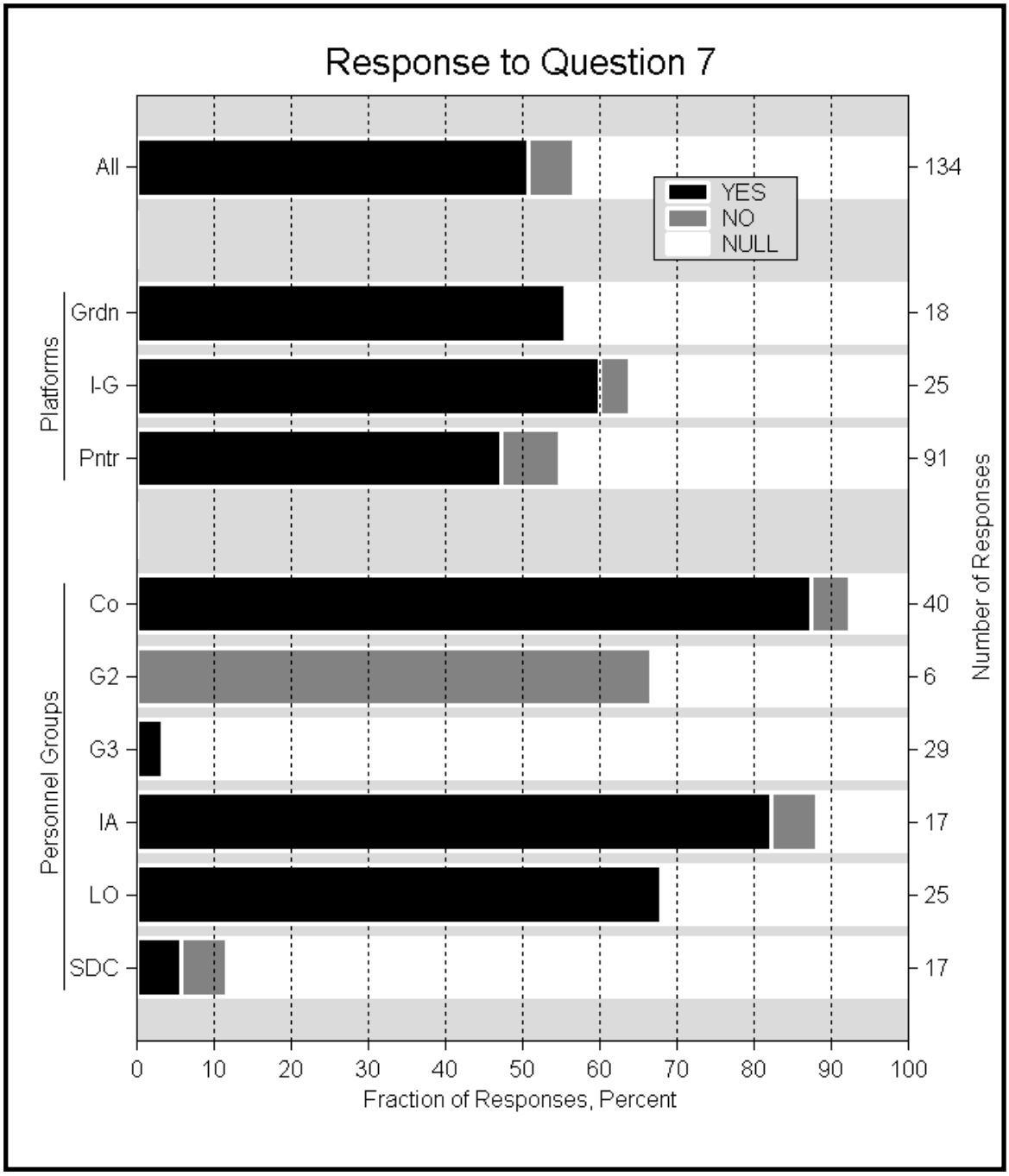

Figure B-10: Response to Question 7

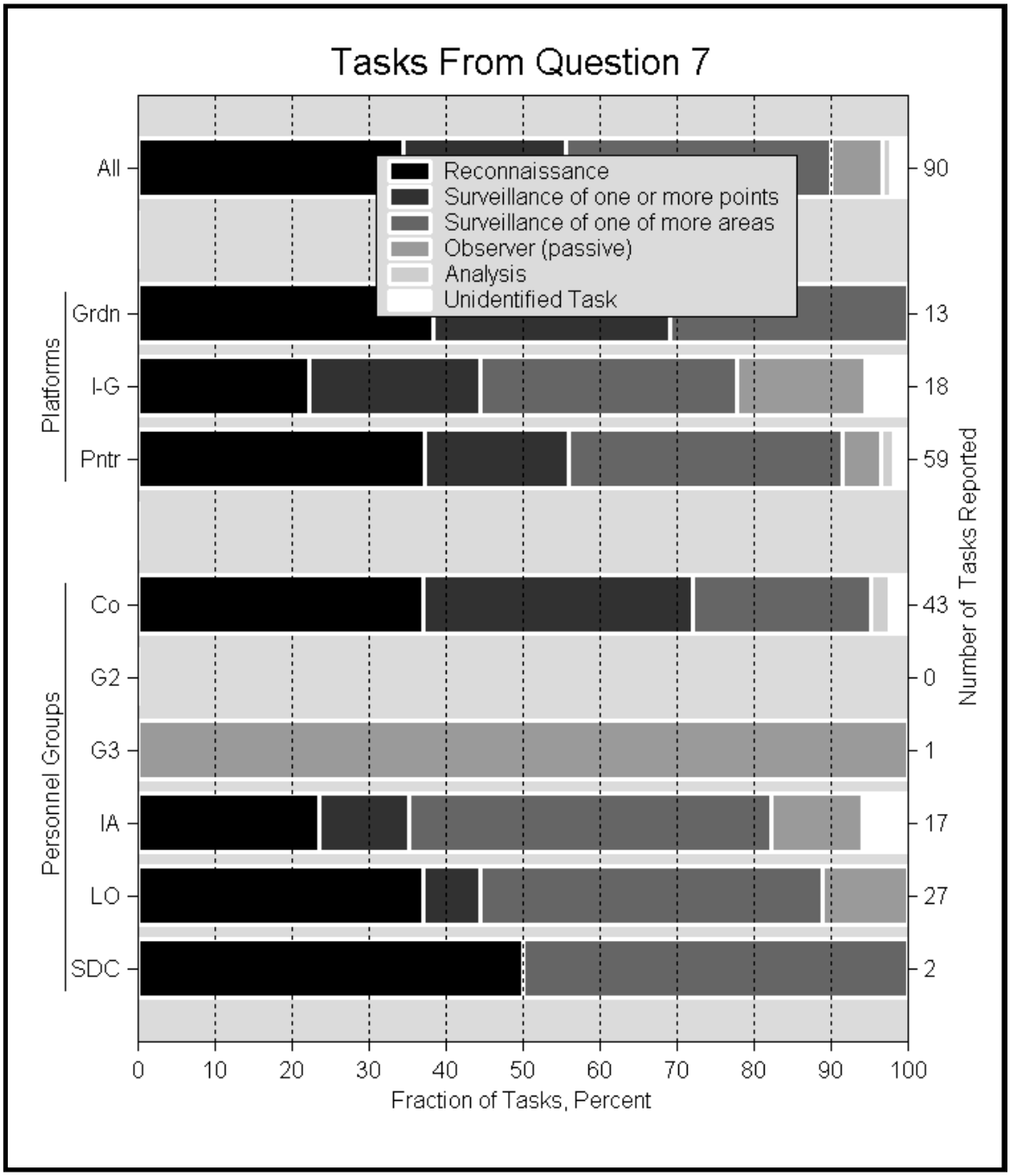

Figure B-11: Tasks Reported in Question 7

B-VIII CHAIN OF COMMAND

27. Question 8 is:

"Describe your chain of command related to the UAV mission"

28. The principal response categories are plotted in Figure B-12. The highlights are:

a. All. 58% ± 8% of respondents gave a description of their chain of command;

b. Platforms. The fraction of respondents who gave a description is nearly the same (about 60% ± 18%) for all platforms; and

c. Personnel Groups.

(1) The Contractor (Co, 84% ± 11%), Image Analyst (IA, 71% ± 20%), and Liaison Officer (LO, 83% ± 13%) personnel groups had large description fractions; and

(2) The Ground Intelligence (G3, 15% ± 12%) and (SDC, 24% ± 18%) had low description fractions.

29. From the "Description Stated" responses of Figure B-12, the ancillary categories generated correspond to the number of levels clearly identified in a respondent's description of the command chain (i.e. "Described N Levels", where $N = 1, 2, 3, 4,$ or 5).

30. The description categories from Question 8 are plotted in Figure B-13. The highlights are:

a. All. 38% ± 11% of descriptions identified two command levels, and 35% ± 11% identified three command levels;

b. Platforms. Most Guardian (Grdn) staff descriptions (53% ± 30%) indicate five command levels, and the highest fraction of I-Gnat (I-G) staff descriptions (48% ± 25%) and Pointer (Pntr) staff descriptions (44% ± 14%) indicate two levels; and

c. Personnel Groups.

(1) Most (64% ± 16%) Contractor (Co) descriptions indicate two command levels;

(2) For the Image Analyst (IA) personnel, the most common description indicated one command level (47% ± 27%); and

(3) Most (87% ± 12%) Liaison Officer (LO) descriptions indicate three command levels.

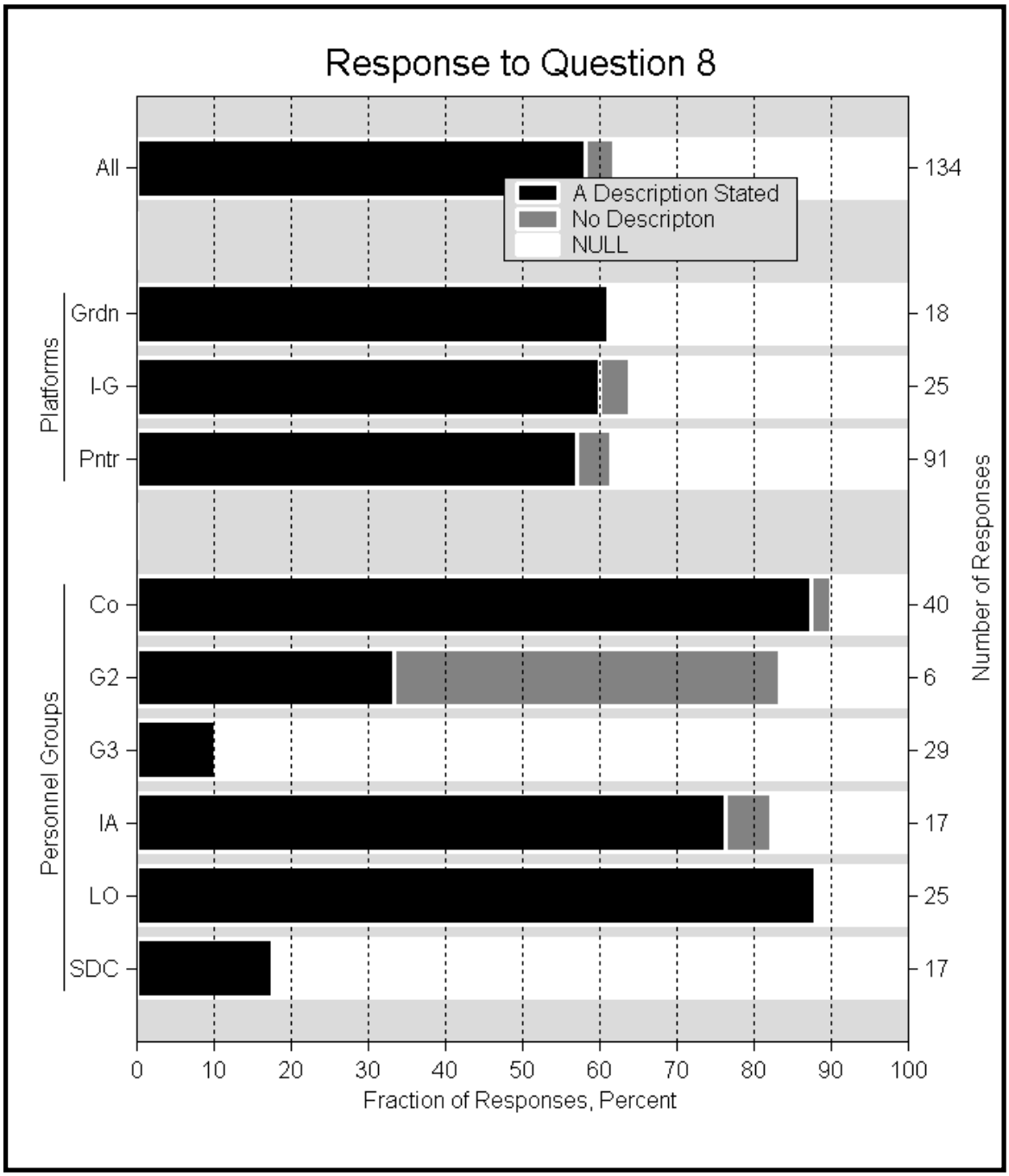

Figure B-12: Response to Question 8

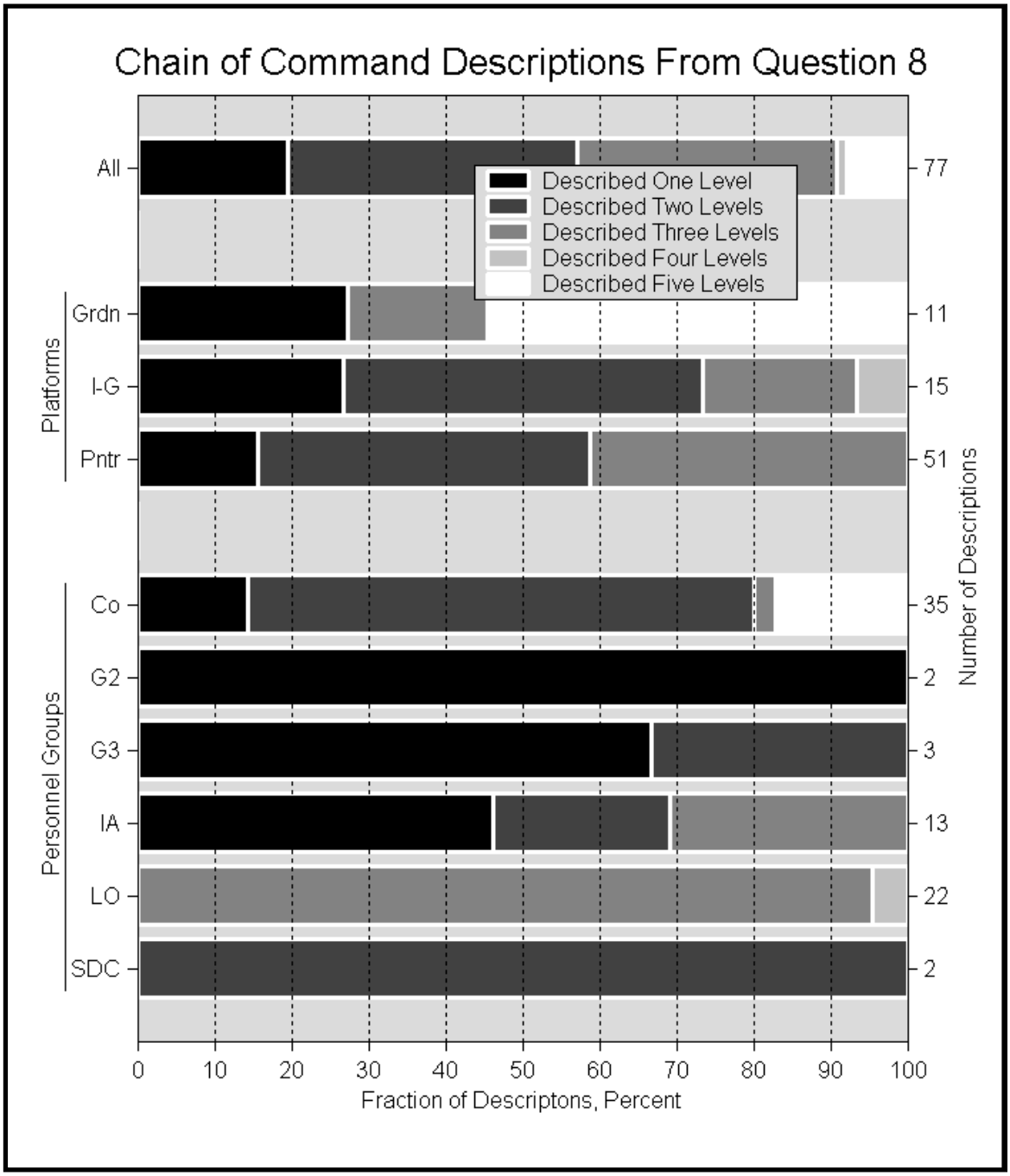

Figure B-13: Chain of Command Descriptions from Question 8

B-IX COMMUNICATION METHODS

31. Question 9 is:

"How did you interact with the ISR Comd?"

32. The principal response categories are plotted in Figure B-14. The highlights are:

a. All. Only 12% ± 5% described the means by which they interacted with ISR command (note that many respondents interpreted "how did you interact" as asking "did you interact successfully");

b. Platforms. Only the Pointer (Pntr) staff stated a description; and

c. Personnel Groups.

(1) The Liaison Officer (LO) group had the largest fraction (52% ± 19%) of responses providing descriptions;

(2) The Ground Operations (G3) group and the Image Analyst (IA) group had the small fractions providing descriptions (9% ± 9% and 15% ± 14% respectively); and

(3) The other three groups gave no descriptions.

33. From the "A Description Stated" responses of Figure B-14, the following ancillary categories of descriptions were generated (the respondents were permitted to identify one or more means of communication):

a. Electronic (digital) files;

b. Voice, radio;

c. Teleconference (digital link); and

d. Voice, telephone

34. The description categories from Question 9 are plotted in Figure B-15. The highlights are:

a. All. Most descriptions (50% ± 18%) indicate voice communication via radio, and the next greatest number of descriptions (44% ± 18%) mention electronic files (i.e. e-mail);

b. Platforms. Since the Pointer (Pntr) staff were the only platform group to respond, their description fractions are identical to the "All" results; and

c. Personnel Groups.

(1) Two groups gave only one description: Ground Operations (G3, Voice, radio) and the Image Analysts (IA, Voice, telephone); and

(2) The Liaison Officer (LO) group gave 26 descriptions, whose fractions are similar to the "All" description fractions.

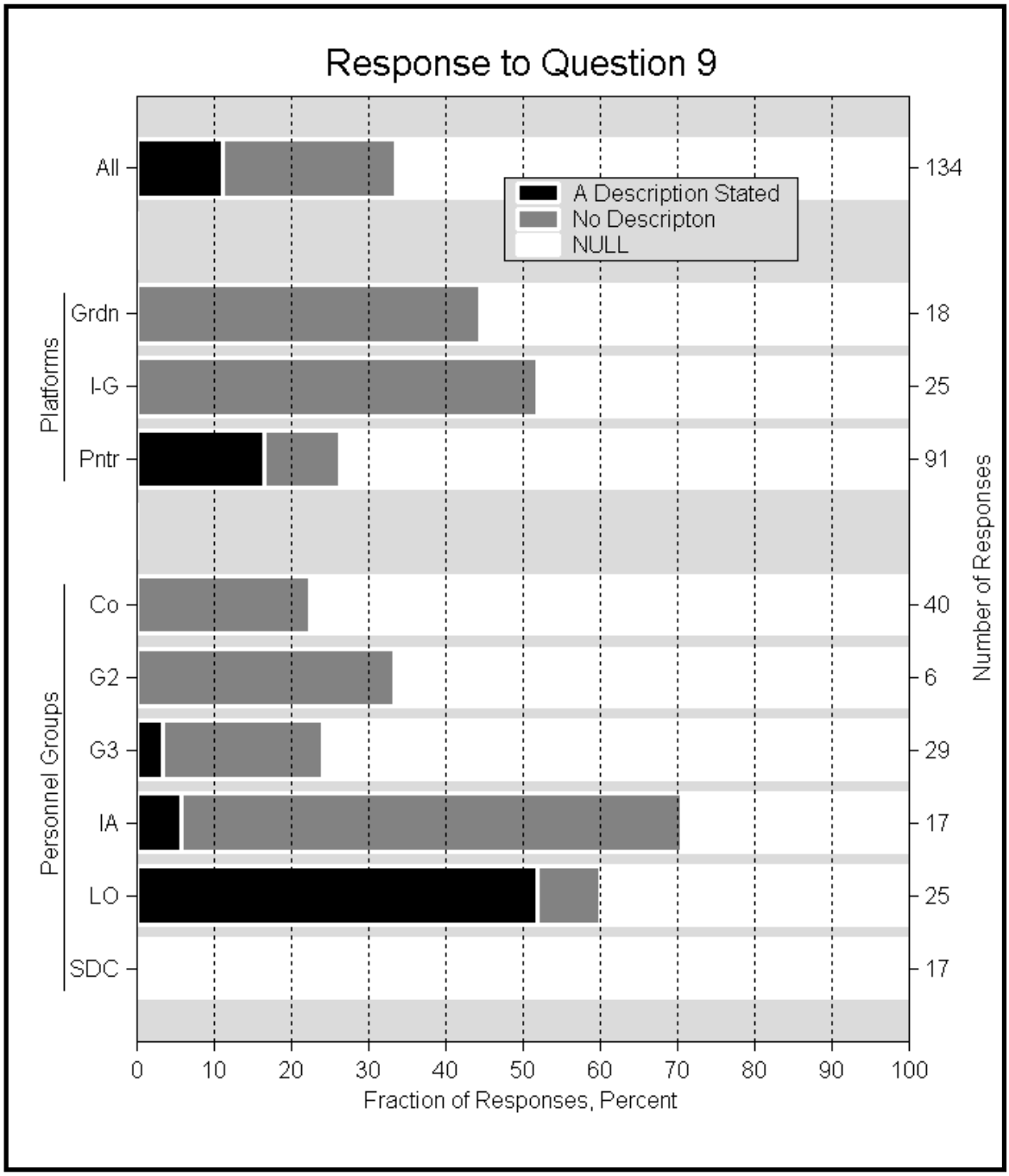

Figure B-14: Response to Question 9

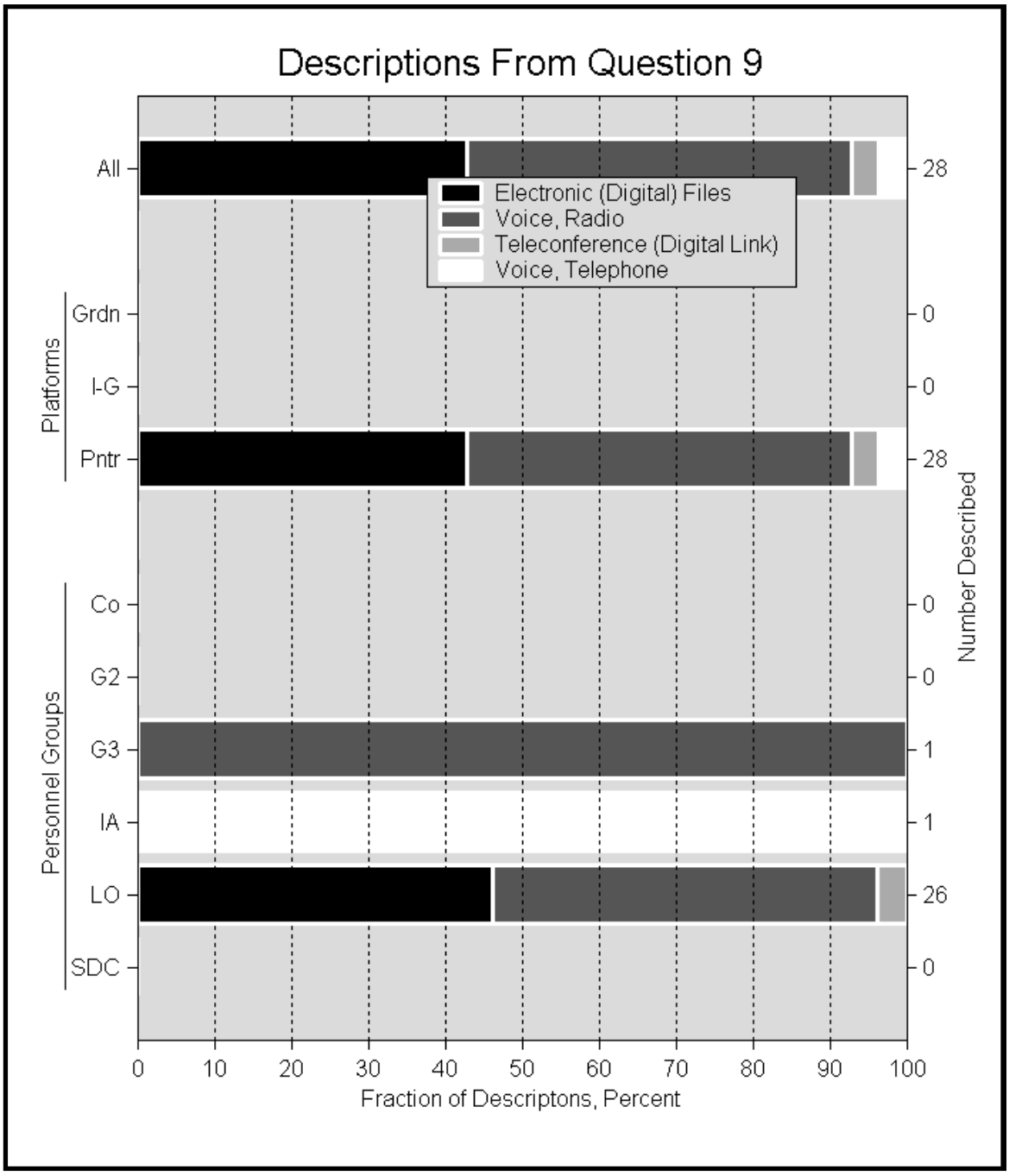

Figure B-15: Descriptions from Question 9

B-X AIRSPACE ARRANGMENTS

35. Question 10 is:

> "Were the UAV airspace arrangements flexible enough to permit effective use of the UAV?"

36. The principal categories (yes, no, and null) are plotted in Figure B-16. The highlights are:

a. All. 67% ± 8% of respondents thought the UAV airspace arrangements were flexible enough;

b. Platforms. Between 54% ± 22% and 69% ± 9%of the staff of all three platforms were satisfied with the airspace arrangements; and

c. Personnel Groups.

(1) The Contractor (Co) group had the largest fraction (91% ± 8%) of respondents who were satisfied with the airspace arrangements;

(2) The Ground Operations (G3) group had the smallest fraction (15% ± 12%) satisfied with the airspace arrangements and the largest null response fraction (85% ± 12%); and

(3) The Scientific Data Collection (SDC) group had the largest fraction (15% ± 14%) who explicitly expressed dissatisfaction with the airspace arrangements.

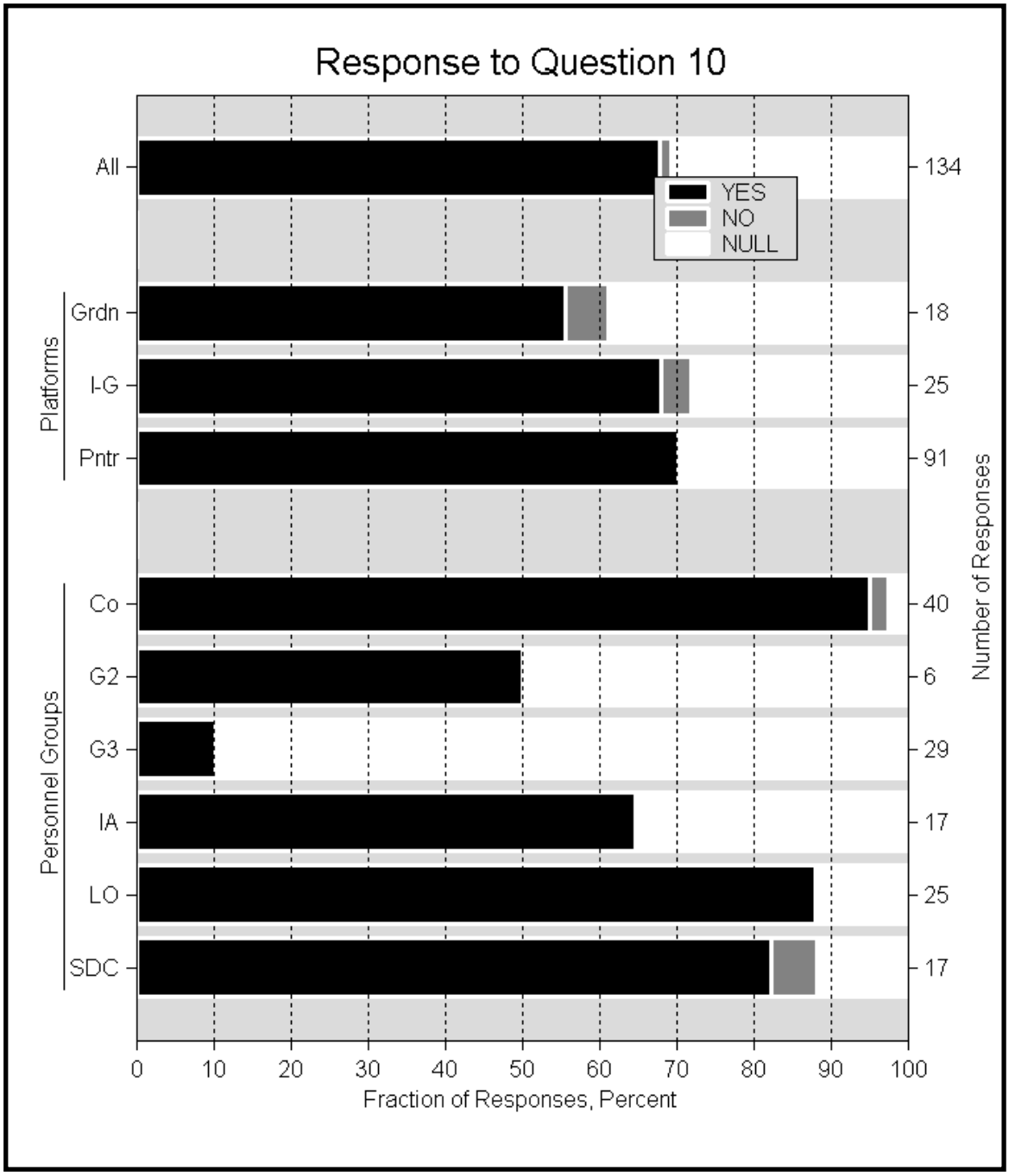

Figure B-16: Response to Question 10

B-XI TIMELINESS OF IMAGERY

37. Question 11 is:

"Were you satisfied with the timeliness of the UAV product?"

38. The response categories (yes, no, and null) are plotted in Figure B-17. The highlights are:

a. All. 39% ± 8% were satisfied with the timeliness of the UAV (imagery) product;

b. Platforms. The I-Gnat (I-G) staff had the largest fraction (59% ± 19% yes) who were satisfied, whereas the Guardian (Grdn) staff had the largest fraction who were dissatisfied (32% ± 20% no); and

c. Personnel Groups.

(1) The Contractor (Co) group was most satisfied (91% ± 8% yes) with the speed at which UAV imagery was made available;

(2) The Image Analyst (IA) group was most dissatisfied (43% ± 22% no) with the promptness of UAV products; and

(3) The Ground Operations (G3) group gave the highest null response fraction (all 29 responses, or 94% ± 6%).

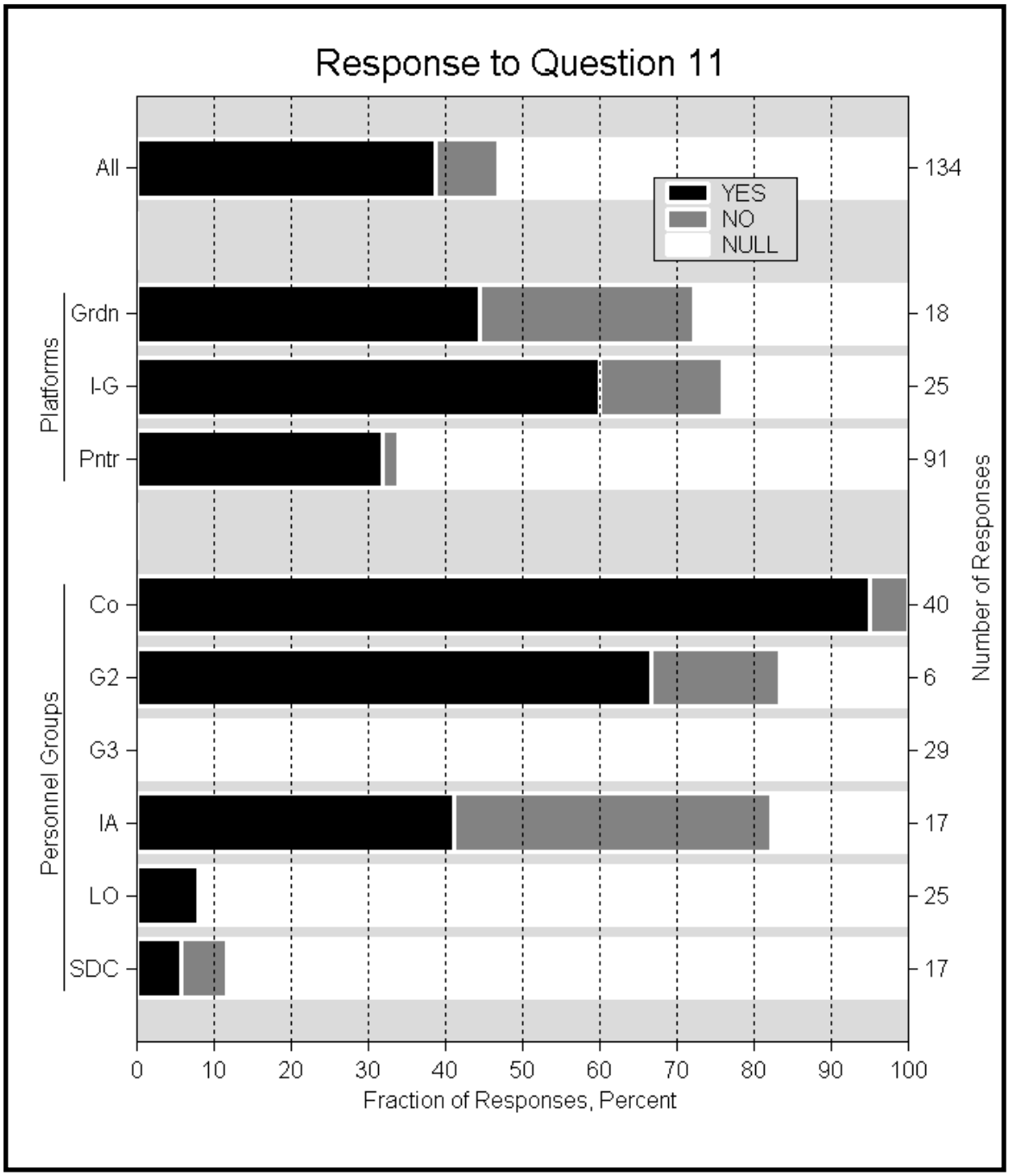

Figure B-17: Response to Question 11

B-XII BEST SUITED IMAGERY

39. Question 12 is:

> "What type of product was best suited for your tasks (still, motion or live streaming video imagery)? Would you have preferred an-other type of imagery?"

40. The principal categories are plotted in

41. Figure B-18. The highlights are:

a. All. 33% ± 8% stated a preference;

b. Platforms. The staff of all three platforms gave response fractions similar to the "All" case; and

c. Personnel Groups.

(1) The Contractor (Co) group had the largest fraction (73% ± 13%) who stated a preferred image type;

(2) The Liaison Officer (LO) group had the largest fraction (65% ± 18%) who explicitly expressed that they had no preference; and

(3) The Ground Operations (G3) had the largest null response fraction (91% ± 9%).

42. From the "An Imagery Preference" response of

Figure B-18, the following preference categories were generated (the respondent was permitted to indicate one or more preferences):

a. Still imagery;

b. Live (streaming) video; and

c. Other.

43. The ancillary categories of preferences from Question 12 are plotted in Figure B-19. The highlights are:

a. All. The majority (68% ± 13%) preferred live (streaming) video;

b. Platforms. The Guardian (Grdn) staff had the largest fraction (39% ± 29%) that preferred still imagery and the Pointer (Pntr) staff had the largest fraction (84% ± 13%) that preferred live (streaming) video; and

c. Personnel Groups.

(1) The Contractor (Co) group had the largest fraction (86% ± 11%) preferring live (streaming) video;

(2) The Image Analyst (IA) group had the largest fraction (32% ± 27%) preferring still imagery, and had the second largest null response fraction (54% ± 30%).

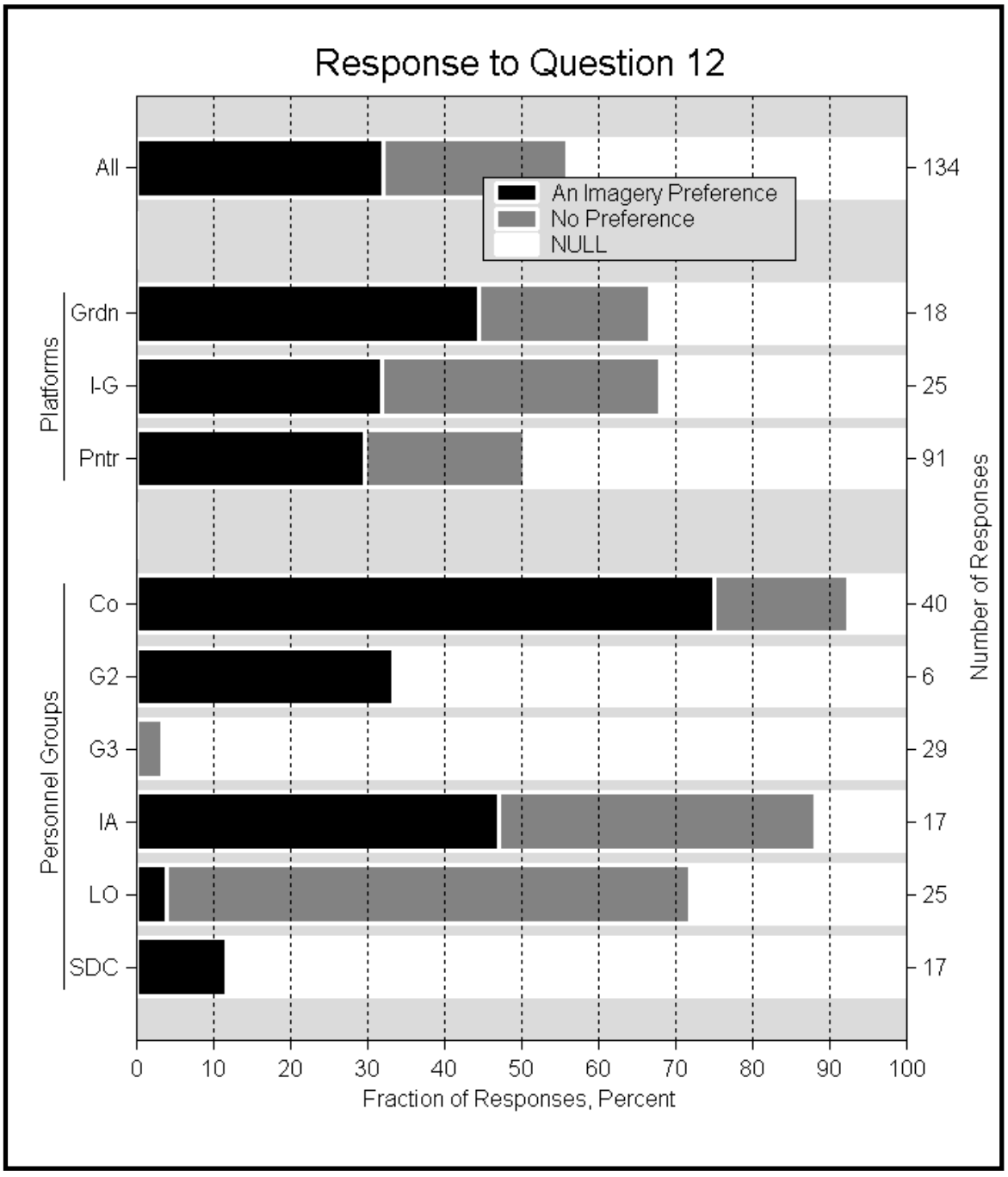

Figure B-18: Response to Question 12

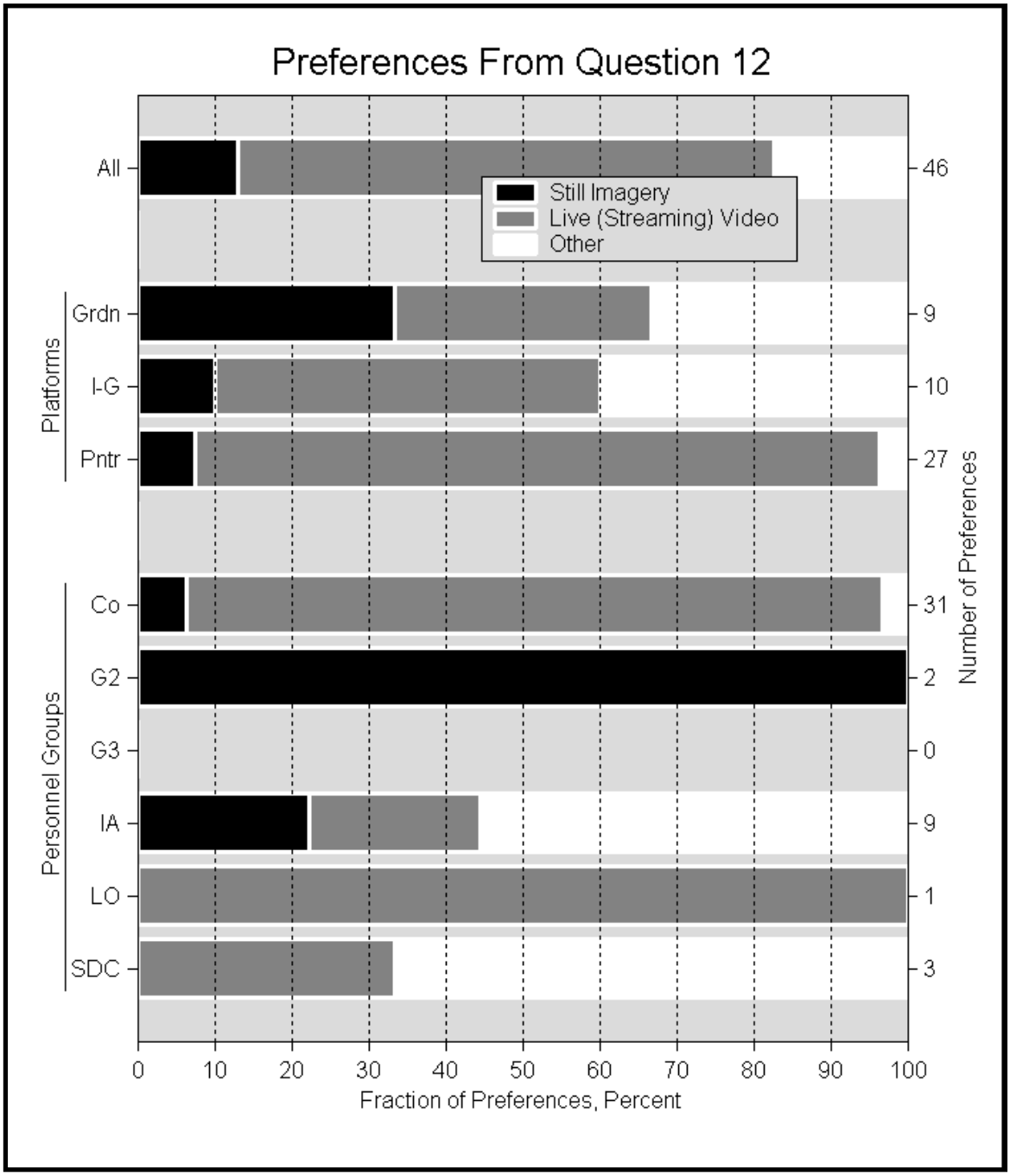

Figure B-19: Preferences from Question 1

ANNEX C
DOR(JOINT) RN 2003/05
SEPTEMBER 2003

ANNEX C: SURVEY RESULTS FROM OPERATION GRIZZLY

1. The results of the content analysis are presented in standard pie charts, in which the size of each pie slice is proportional to the fraction (of 24 responses) that fall into a particular response category. The following sections discuss each question in turn. The discussion includes the definition of the response categories and any question-specific details regarding the content analysis (see Annex B for Exercise Robust Ram results).

WARNING

2. The pie charts show the observed response fractions; however, the numbers reported in the text are the population proportion and the margin of error, both of which are computed from the observed response fraction and the number of responses at the 95% confidence level (i.e. 19 times out of 20, the observed fraction shall fall within the margin of error about the population proportion). Therefore, the estimates of the population proportions do not necessarily sum to 100%, since they merely indicate the point about which the margin of error is centred. See Annex D for further details.

C-I PERSONNEL SKILLS AND RESOURCES

3. Question 1 is:

> "Did you have sufficient personnel skills and resources to utilize the UAV information effectively?"

4. Figure C-1 shows the pie chart for the content analysis of question 1. The highlights are:

a. 71% ± 17% of the responses thought that there were sufficient personnel and skills; and

b. There were no null responses.

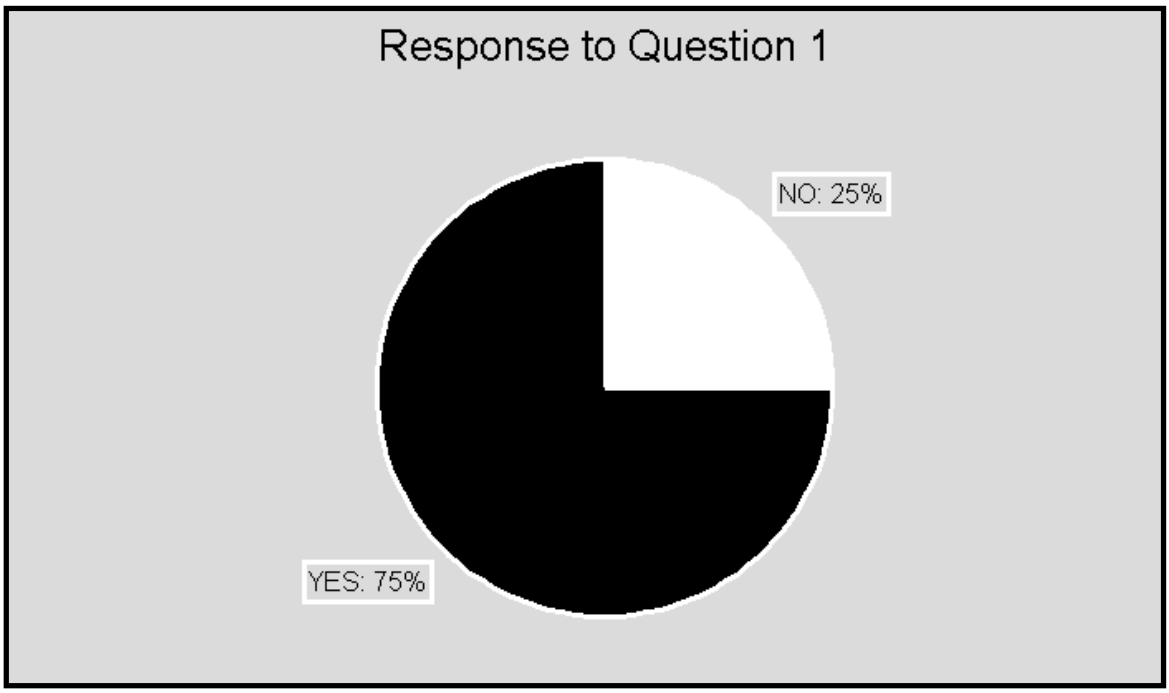

Figure C-1: Response to Question 1

C-II PERSONNEL SUGGESTIONS

5. Question 2 is:

"Any personnel suggestions?"

6. The principal categories are plotted in Figure C-2; 75% ± 16% of the respondents made suggestions (i.e. answered "yes" in Figure C-2).

7. The following ancillary categories of personnel suggestions were generated from the "yes" responses of Figure C-2:

a. More/better Image Analysts (IA);

b. Have an effective Mission Commander (MC);

c. More Intelligence Surveillance, and Reconnaissance (ISR) Liaison Officers (LO);

d. Better aircraft Maintenance and Support (MS);

e. More IT support and/or training;

f. Additional Pilot (AP);

g. A Dedicated tour Guide (DG) for visitors; and

h. Use Personnel Experienced (PE) with multiple sensor operations.

8. The suggestions from question 2 are plotted in Figure C-3. The highlights are (the respondents were permitted to make one or more suggestions):

a. The largest suggestion set (33% ± 20%) was to use Personnel Experienced (PE) with multiple sensor operations;

b. The second largest suggestion set (26% ± 18%) was to have more ISR Liaison Officers (LO); and

c. The third largest suggestion set (23% ± 17%) was to include an Additional Pilot (AP).

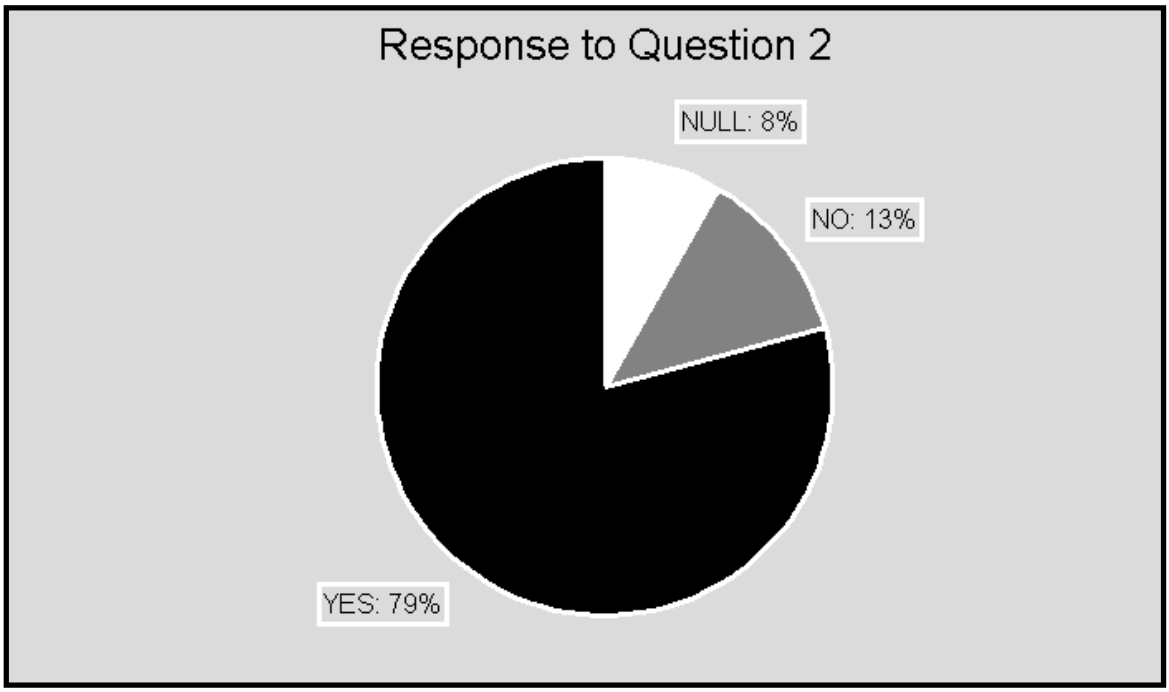

Figure C-2: Response to Question 2.

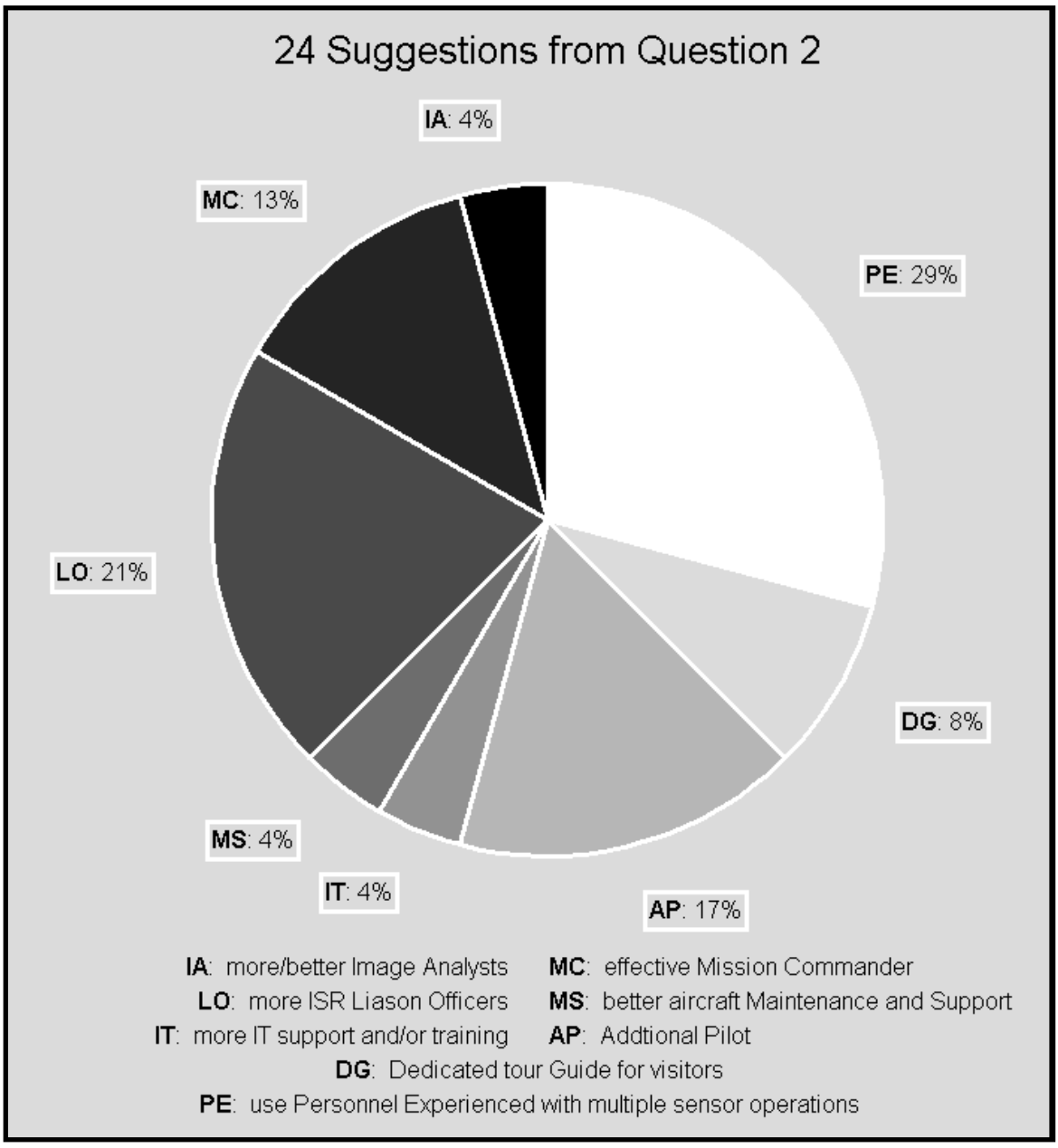

Figure C-3: Suggestions From Question 2

C-III NECESSARY COMMUNICATION

9. Question 3 is:

> "Were you able to talk to everyone you needed regarding the UAV mission?"

10. The principal categories (yes, no, and null) are plotted in Figure C-4. The highlights are:

a. 57% ± 19% of respondents said that they were able to talk to everyone they needed to contact; and

b. The null response fraction was 18% ± 14%.

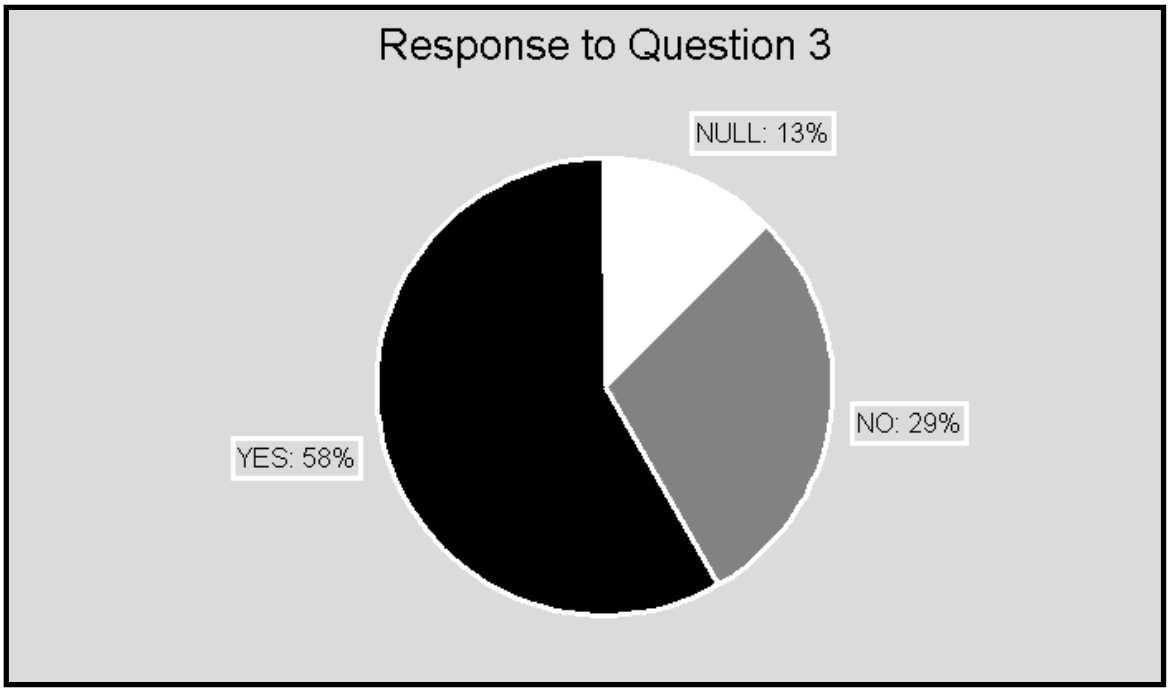

Figure C-4: Responses to Question 3

C-IV PROMPT INFORMATION

11. Question 4 is:

"Did you receive the UAV information promptly?"

12. The response categories (yes, no, and null) are plotted in Figure C-5. The highlights are:

a. 50% ± 19% of the respondents thought that they received UAV information (e.g. imagery) promptly; and

b. b. The null response fraction was 22% ± 15%.

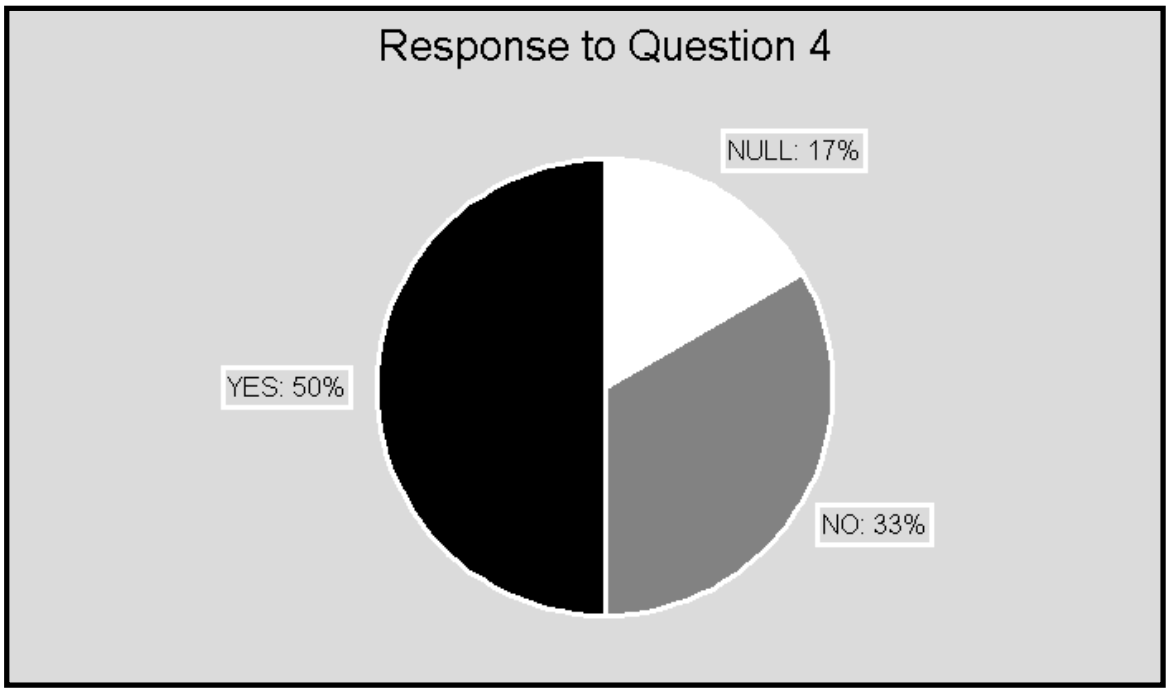

Figure C-5: Response to Question 4

C-V MORE EFFECTIVE COMMUNICATION

13. Question 5 is:

> "What could have been done to make the UAV comm. Structure more effective?"

14. The principal categories are plotted in Figure C-6. The highlights are:

a. 68% ± 18% thought the communication structure could be more effective; and

b. The null response rate was 29% ± 17%.

15. From the "yes" responses of Figure C-6, the following ancillary categories of communications-structure suggestions were generated (the respondents were permitted to make one or more suggestions):

a. Simplify communications Structure (SS);

b. Coordinate Requests (CR) to investigate a Named Area of Interest (NAI);

c. Use Military communication Assets (MA) only;

d. Improve Network (IN);

e. Give the Mission Commander (MC) a communications setup;

f. Broadcast Notices (BN) of contacts of interest;

g. Improve link to and from the Image Analysts (IA); and

h. Provide Forward (PF) ground control station.\

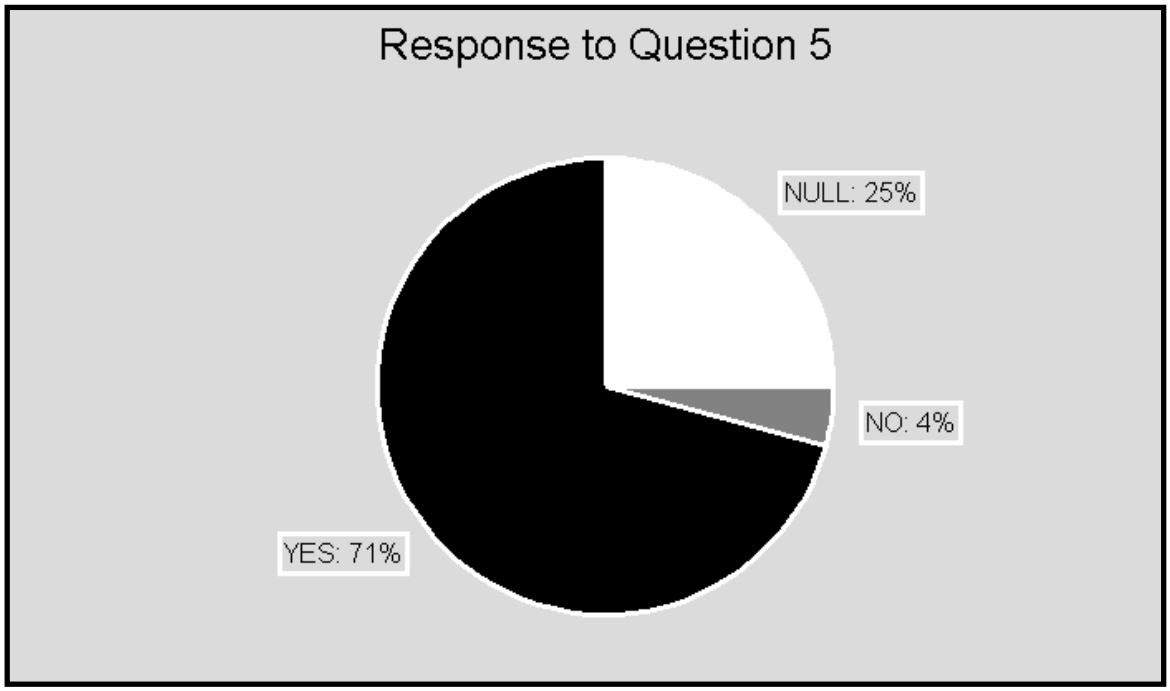

Figure C-6: Response to Question 5

16. The suggestion categories from Question 5 are plotted in Figure C-7. The highlights are:

a. The largest suggestion category (29% ± 22%) is to give the Mission Commander (MC) a communications setup;

b. The second largest (25% ± 21%) suggestion categories are:

(1) To simply the communications structure (SS); and

(2) To improve the network (IN).

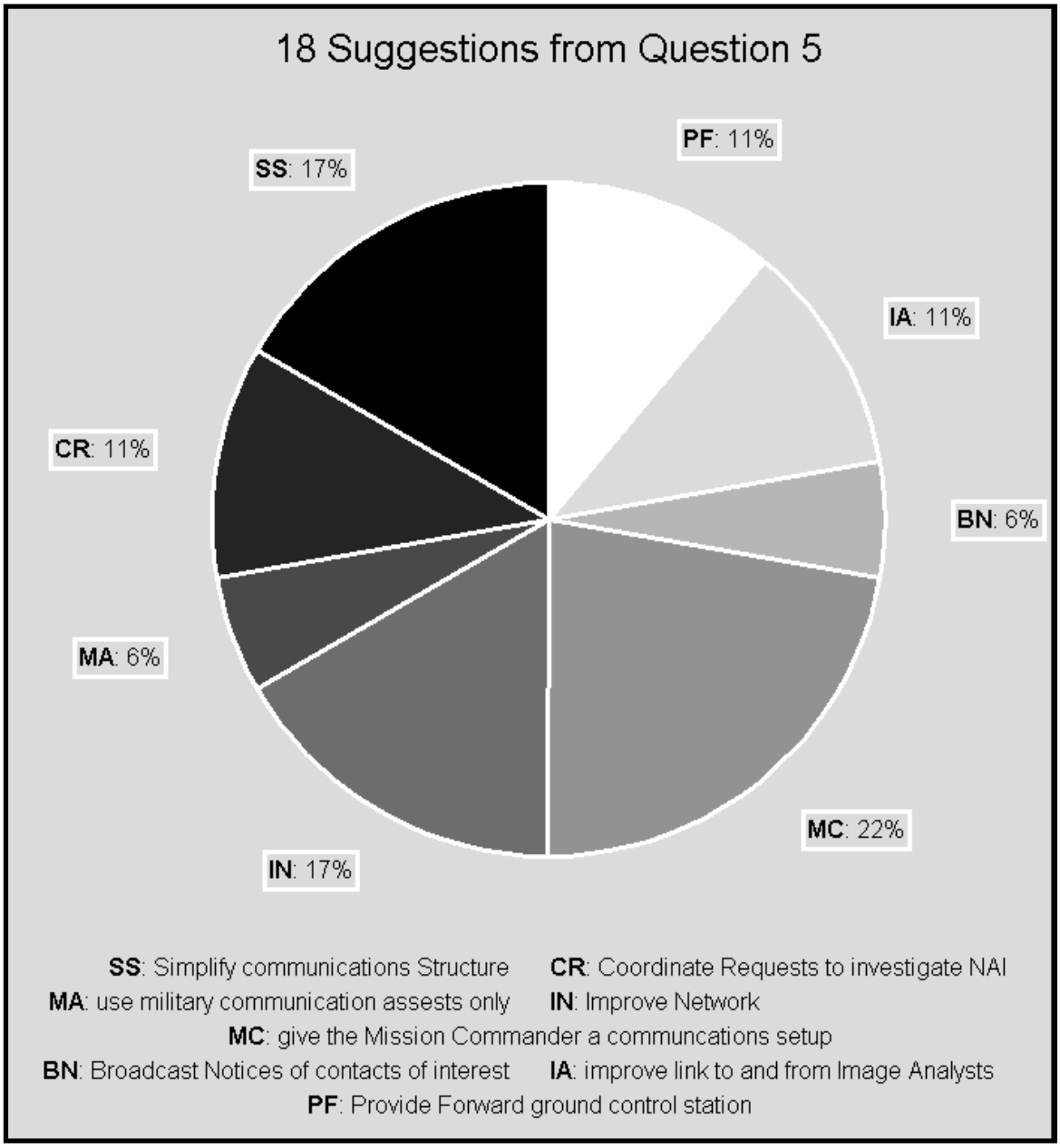

Figure C-7: Suggestions from Question 5

C-VI INFORMATION USE

17. Question 6 is:

"What did you do with the UAV information you received?"

18. The principal categories are plotted in Figure C-8. The highlights are:

a. 82% ± 14% of respondents reported that they did something with the UAV information that they received; and

b. 18% ± 14% did nothing with their received information.

19. From the "something was done" responses of Figure C-8, the following activity categories (i.e. image data usage) were generated (the respondents were permitted to identify one or more activities):

a. Surveillance (S) and reconnaissance;

b. Transmitted (T) during operation;

c. Analyzed (A) during operation;

d. Recorded (R) it; and

e. Used it during operation (U).

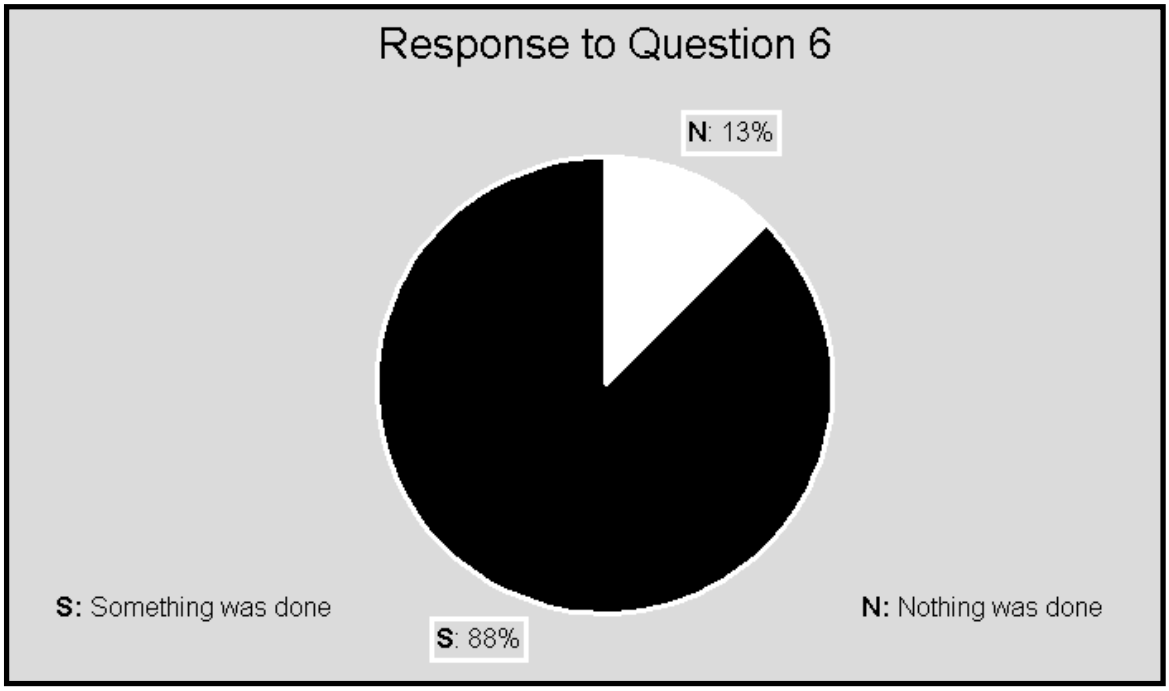

Figure C-8: Response to Question 6

20. The activity categories from Question 6 are plotted in Figure C-9. The highlights:

    a. The largest activity category (30% ± 17%) is that the UAV information was used during operation (U); and

    b. The next largest activity categories (17% ± 14%) are:

        (1) Surveillance and reconnaissance (S); and

        (2) Analyzed (A) UAV imagery during operation.

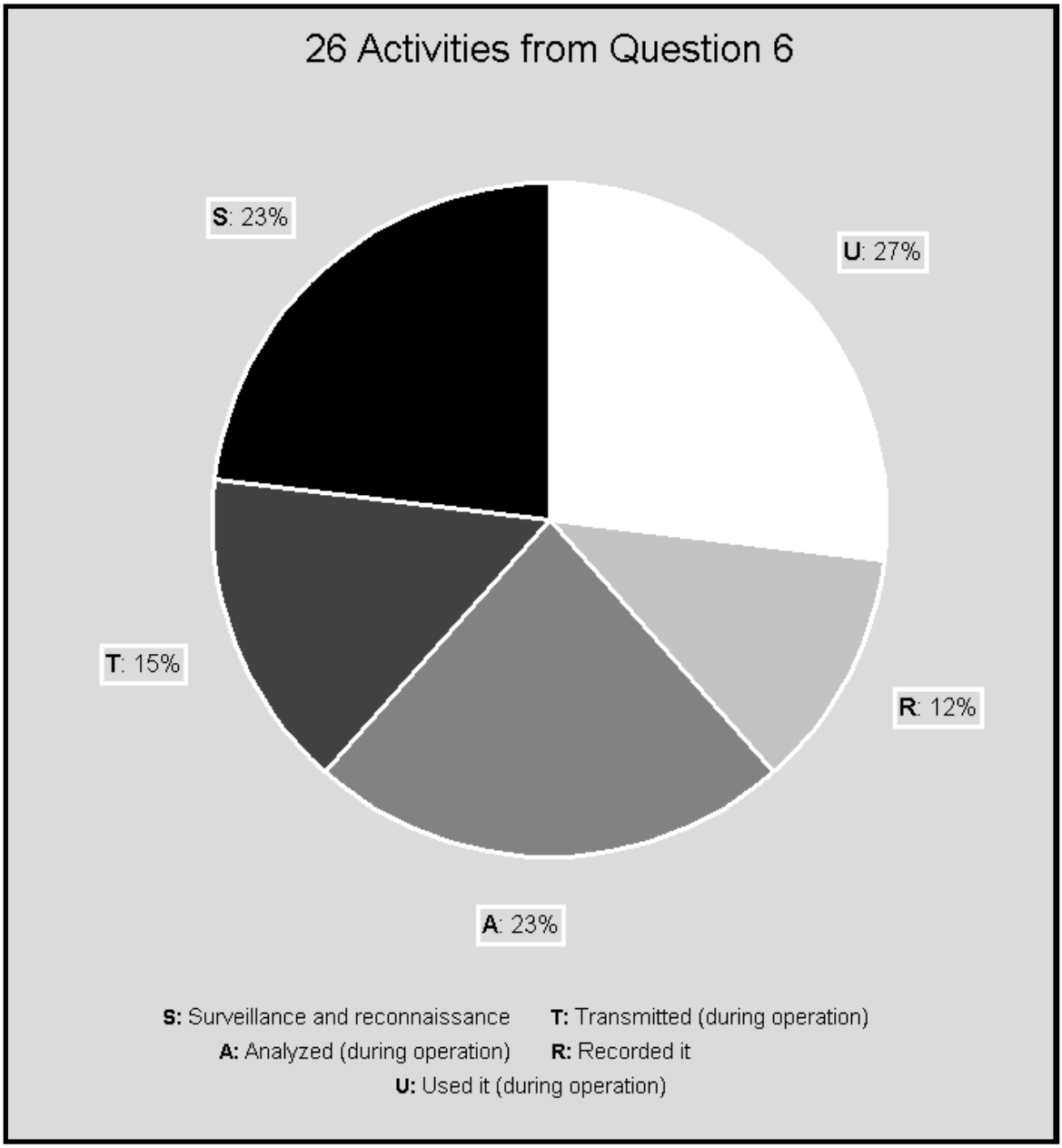

Figure C-9: Activities Identified in Question 6

C-VII UAV IMAGERY TASKS

21. Question 7 is:

"Did you receive a tasking involving UAV imagery? What was it?"

22. The principal categories are plotted in Figure C-10. The highlights are:

a. 54% ± 19% of respondents reported that they received a task; and

b. The null response fraction was 43% ± 19%.

23. From the "yes" responses of Figure C-10, the following task categories were generated (the respondents were permitted to identify one or more tasks):

a. Reconnaissance (R);

b. Surveillance (S);

c. Analysis (A); and

d. Unidentified mission (U).

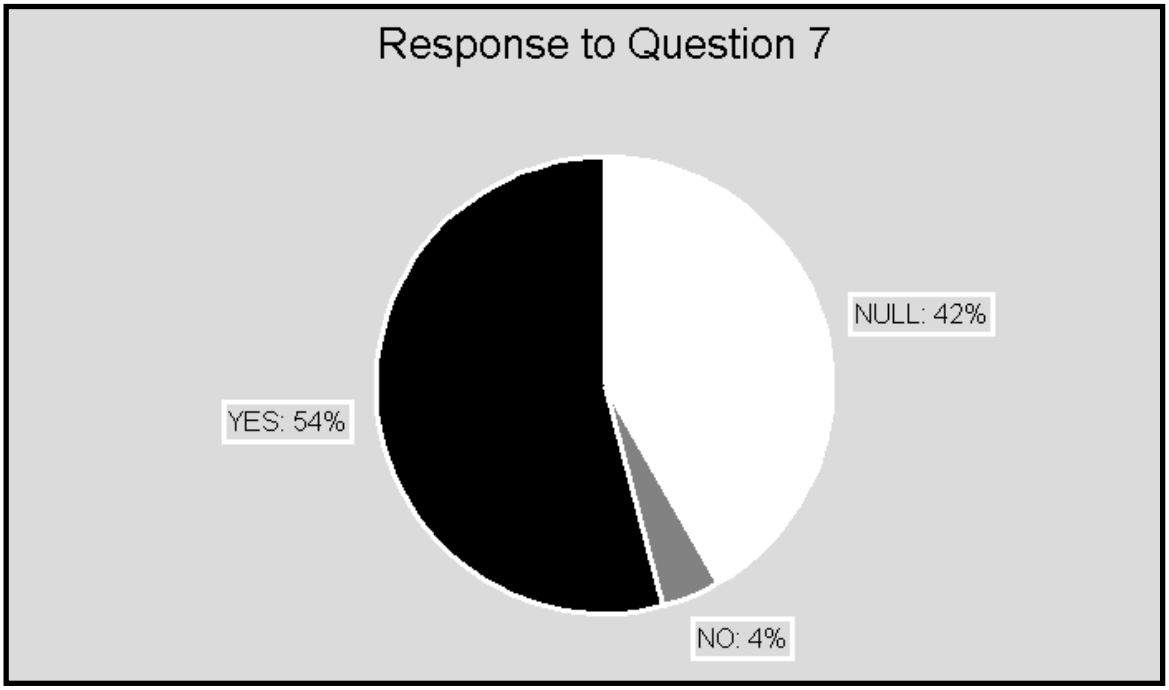

Figure C-10: Response to Question 7

24. The activity categories from Question 7 are plotted in Figure C-11. The highlights are:

a. The largest activity category (47% ± 25%) was due to respondents indicating that they did receive a task, but not identifying the task (U);

b. The second largest activity category (42% ± 24%) indicates personnel engaged in a reconnaissance task (R); and

c. The smallest activity categories (17% ± 16%) are Surveillance (S) and Analysis (A).

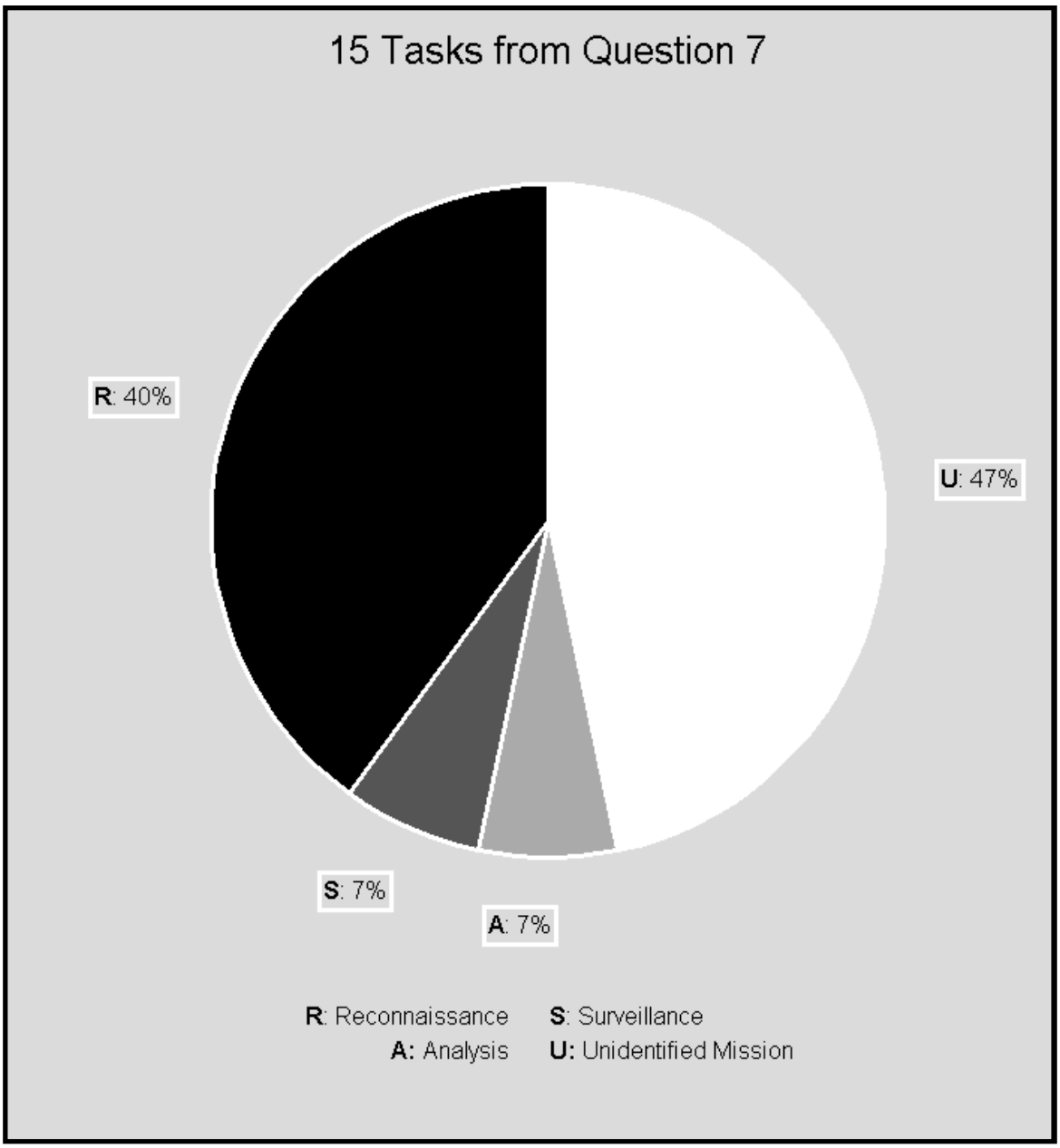

Figure C-11: Tasks Reported in Question 7

C-VIII CHAIN OF COMMAND

25. Question 8 is:

"Describe your chain of command related to the UAV mission"

26. All respondents gave a description of the chain of command. The resulting ancillary categories correspond to the number of levels clearly identified in a respondent's description of the command chain (i.e. "described *N* command Levels", where $N = 1, 2, 3,$ or 4).

27. The description categories from Question 8 are plotted in Figure C-12. The highlights are:

a. 36% ± 19% described two levels (2L) of command; and

b. 32% ± 18% described one level (1L) of command.

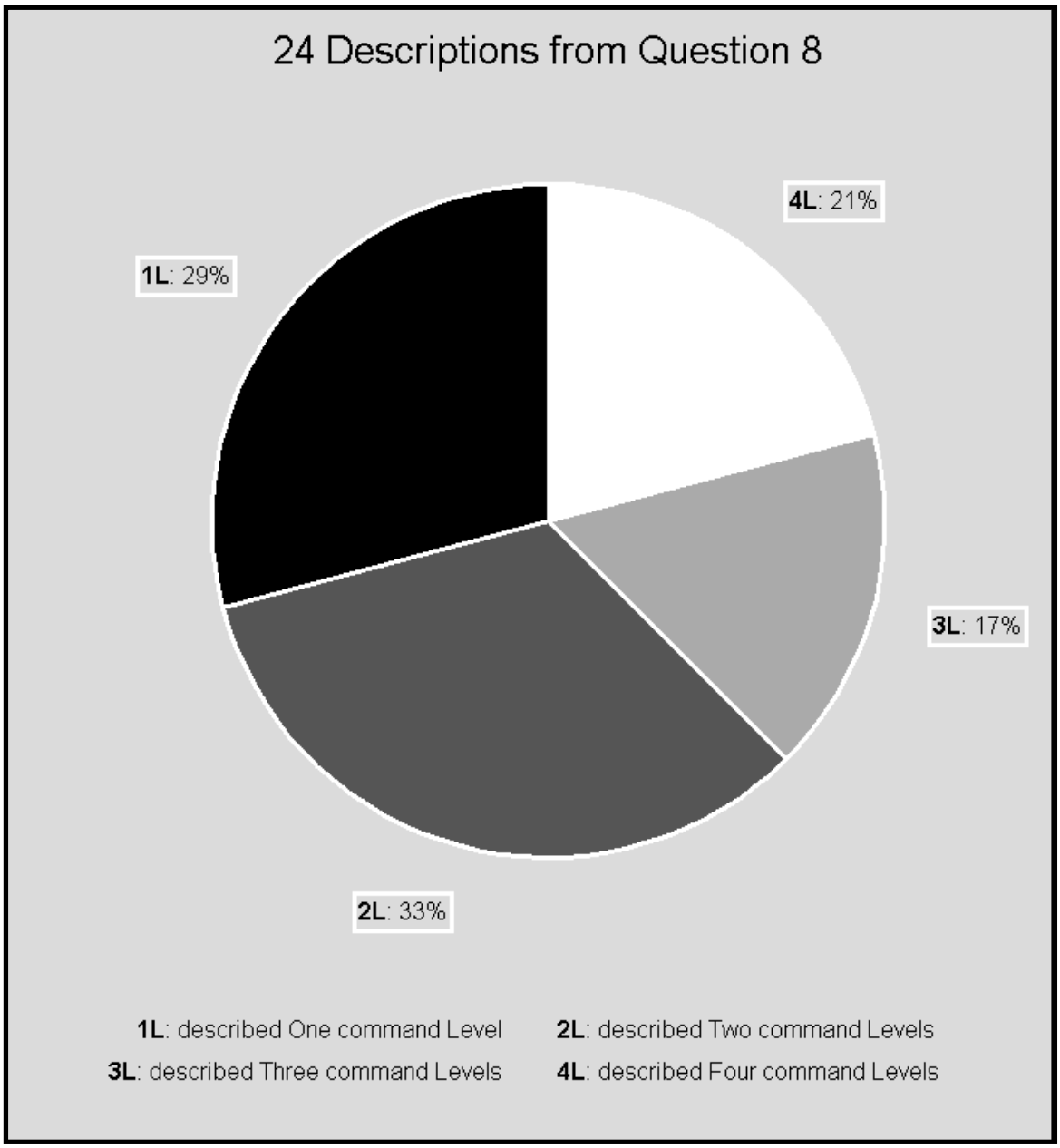

Figure C-12: Chain of Command Descriptions from Question 8

C-IX COMMUNICATION METHODS

28. Question 9 is:

"How did you interact with the ISR Comd?"

29. The principal response categories are plotted in **Figure C-13**. The highlights are:

a. 50% ± 19% of the respondents reported that they interacted with the ISR command, but gave no description of the interaction (N); and

b. The null response fraction was 39% ± 19%.

30. From the "D: a means of communication was Described" responses of **Figure C-13**, the following ancillary categories of descriptions were generated (the respondents were permitted to identify one or more means of communication):

a. Voice Radio (R); and

b. Informal (I) notes.

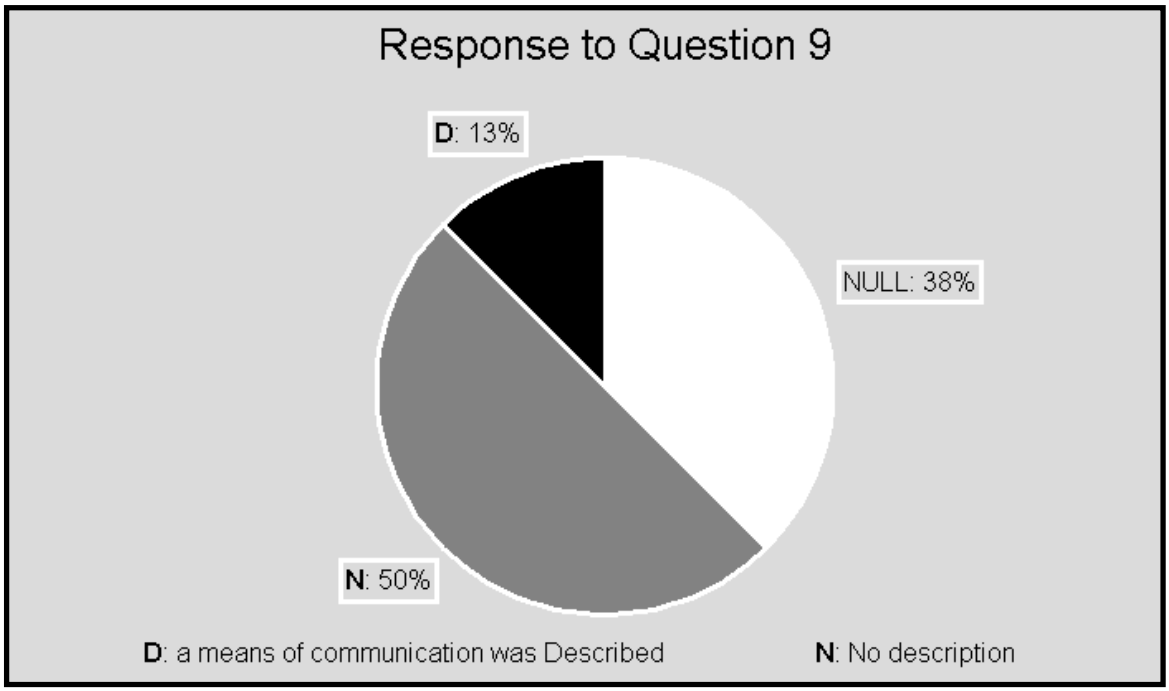

Figure C-13: Response to Question 9

31. The description categories from Question 9 are plotted in Figure C-14. The highlight is that the descriptions were split evenly (50% ± 33%) between voice radio and informal notes.

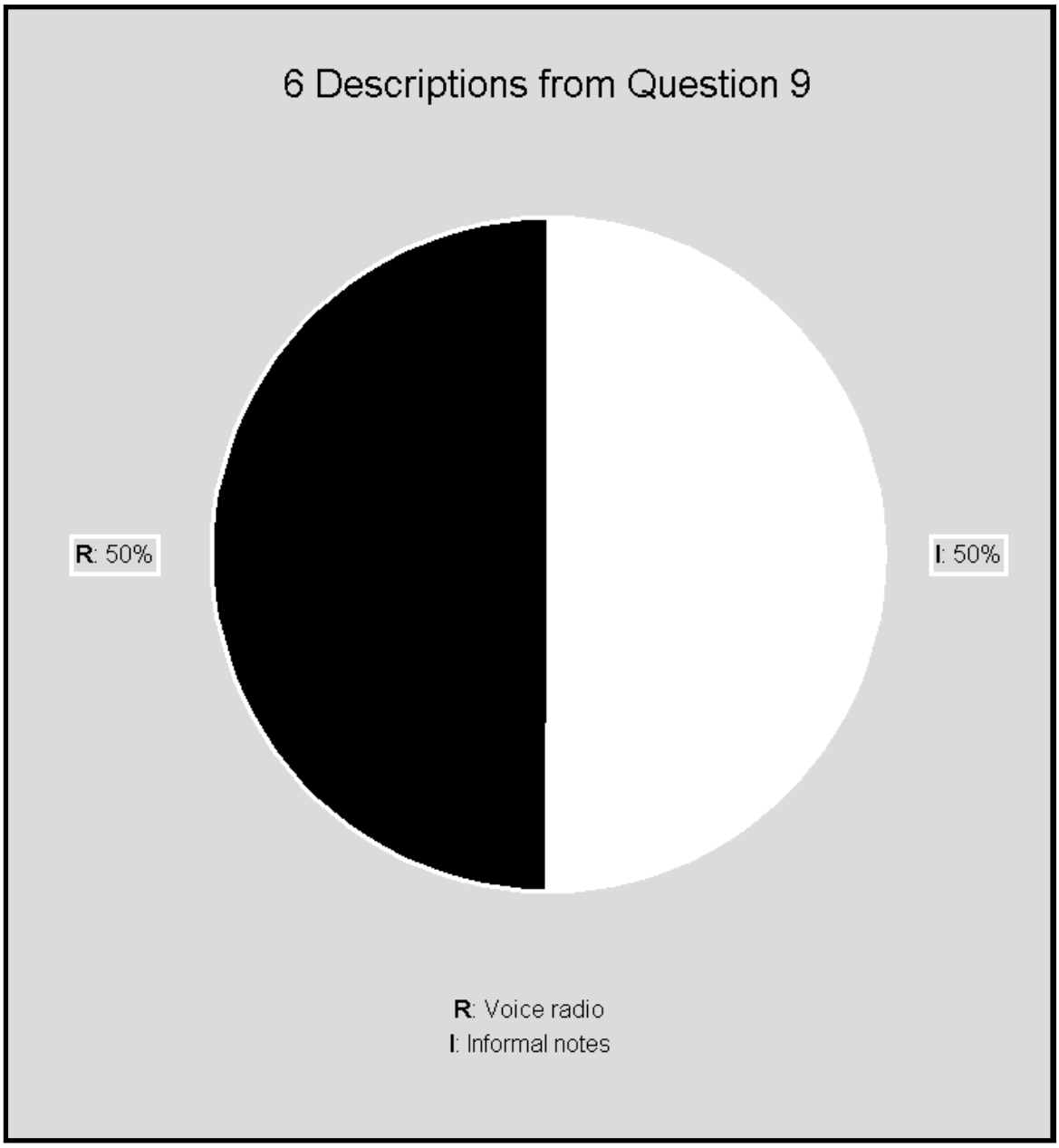

Figure C-14: Descriptions from Question 9

C-X AIRSPACE ARRANGMENTS

32. Question 10 is:

> "Were the UAV airspace arrangements flexible enough to permit effective use of the UAV?"

33. The principal categories (yes, no, and null) are plotted in Figure C-15. The highlights are:

a. 43% ± 19% of respondents thought that the airspace arrangements were flexible enough to permit the effective use of the UAV; and

b. The null response fraction was 22% ± 15%.

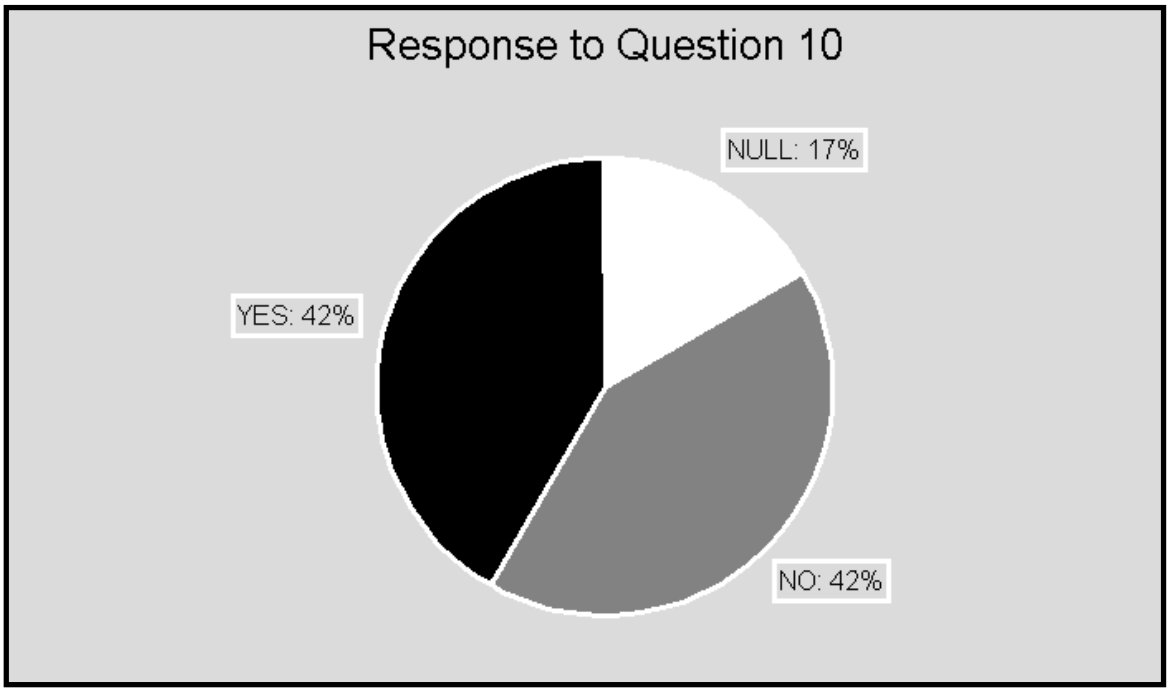

Figure C-15: Response to Question 10

C-XI TIMELINESS OF IMAGERY

34. Question 11 is:

"Were you satisfied with the timeliness of the UAV product?"

35. The principal categories (yes, no, and null) are plotted in Figure C-16. The highlights are:

a. 68% ± 18% of respondents were satisfied with the timeliness of the UAV (e.g. imagery) product; and

b. The null response fraction was 18% ± 14%.

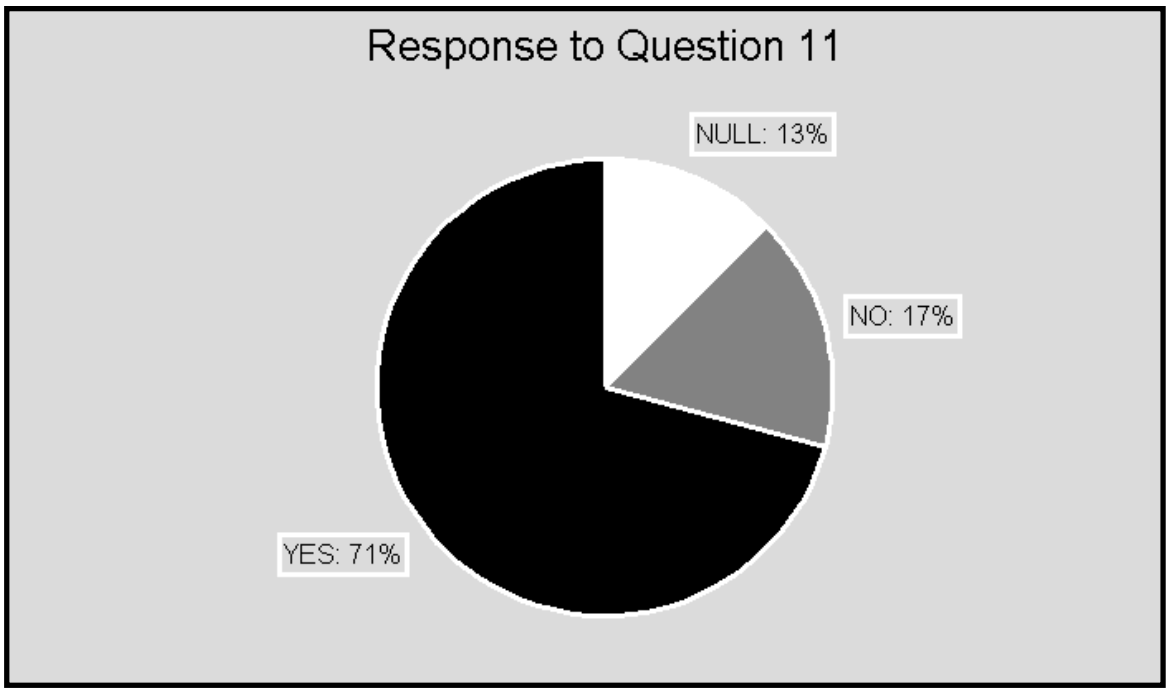

Figure C-16: Response to Question 11

C-XII BEST SUITED IMAGERY

36. Question 12 is:

> "What type of product was best suited for your tasks (still, motion or live streaming video imagery)? Would you have preferred an-other type of imagery?"

37. The principal response categories are plotted in Figure C- 17. The highlights are:

a. 46% ± 19% of respondents reported an imagery preference; and

b. The null response fraction was 29% ± 17%.

38. From the statement of the question (paragraph 0), the following preference categories were generated (one or more preferences was permitted):

a. Still imagery;

b. Motion imagery;

c. Live (streaming) video; and

d. Other imagery.

39. All (87% ± 13%) indicated that their preference was live streaming video.

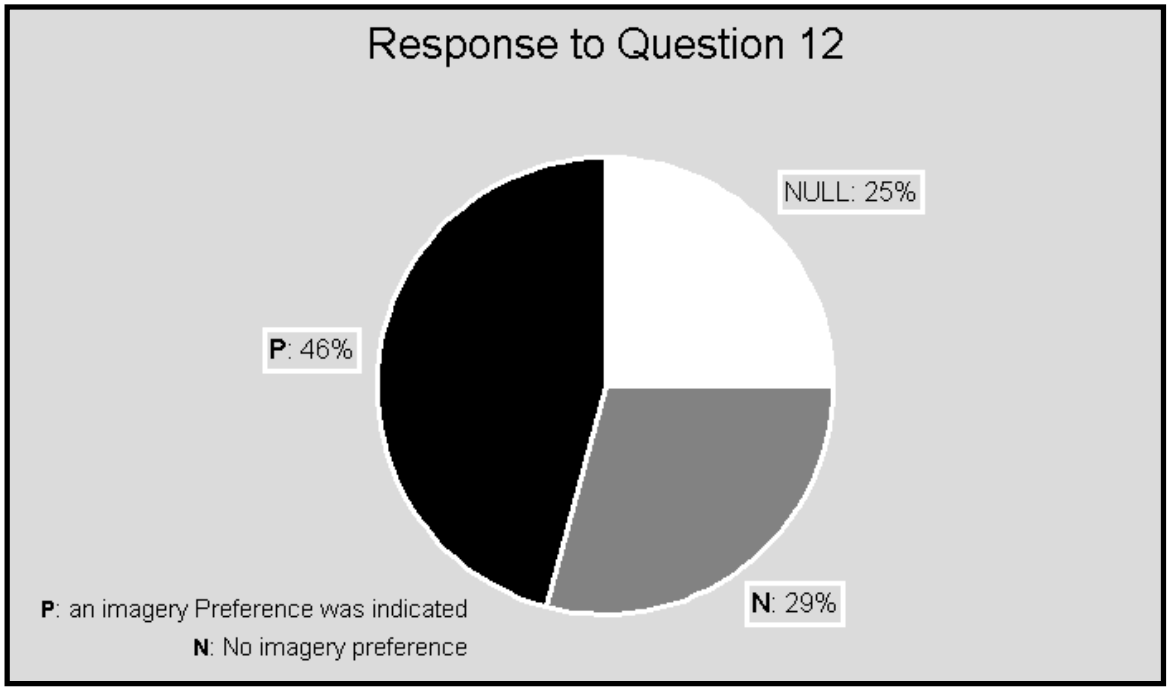

Figure C- 17: Response to Question 12

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ANNEX D: CONFIDENCE INTERVAL ESTIMATES OF THE POPULATION PROPORTION AND THE MARGIN OF ERROR

1. Reference [9] indicates it is appropriate to assume a multinomial distribution for survey data that may belong to more than two categories. The variance of the fraction of responses in each category can be estimated from the results. When the sample size N is less than thirty (i.e. $N \le 30$), the following formula (Reference [10])is required:

$$p = \frac{P + \frac{z_c^2}{2N} \pm z_c \sqrt{\frac{P(1-P)}{N} + \frac{z_c^2}{4N^2}}}{1 + \frac{z_c^2}{N}} \qquad \text{(D-1)}$$

where p is the estimate of the proportion of the population in a category, P is the observed proportion of the population in the same category, and z_c is the confidence coefficient. It is common practice to work at a confidence level of 95%, for which the confidence coefficient is $z_c = 1.96$.

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A Concept Development and Experimentation (CD&E) programme at the Canadian Forces Experimentation Centre (CFEC) is currently investigating Uninhabited Aerial Vehicles (UAV) as components in an Integrated Intelligence, Surveillance, and Reconnaissance Architecture (IISRA). The operational requirement for UAVs is to contribute to the information and intelligence capabilities specified by the Canadian Forces' Strategy 2020. Potentially, the UAV offers the attractive qualities of ease of deployment and broad military capabilities. Experimental UAV squadrons were assembled in order to support Exercise Robust Ram and OPERATION GRIZZLY. This research note describes the analysis of data collected in an improvised questionnaire completed by members of experimental UAV squadrons. The Experimentation Operational Research Team (EXORT) was tasked to analyse the surveys through their role as experiment designers and evaluators at CFEC. An important result is the null response rate, which supports the recommendation that future questionnaires receive a more attention at the design and collection phases. However, more interesting are the useful insights inferred within the survey results' margin of error. Using a content-based analysis method, the experimental UAV squadrons indicated, in many different ways, dissatisfaction with the speed and reliability of the Intelligence, Surveillance and Reconnaissance network. These problems were compounded by the respondents' misapprehension of the chain of command and an impractical preference for live streaming video. From these results, it is concluded that an IISRA must be a clear organisational structure capable of supporting the timely transformation of the most useful UAV data into readily available information and, whenever possible, intelligence. Specific recommendations indicate practical steps to realise of the full potential of UAV operations within an IISRA and to progress toward the goals of Strategy 2020.

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