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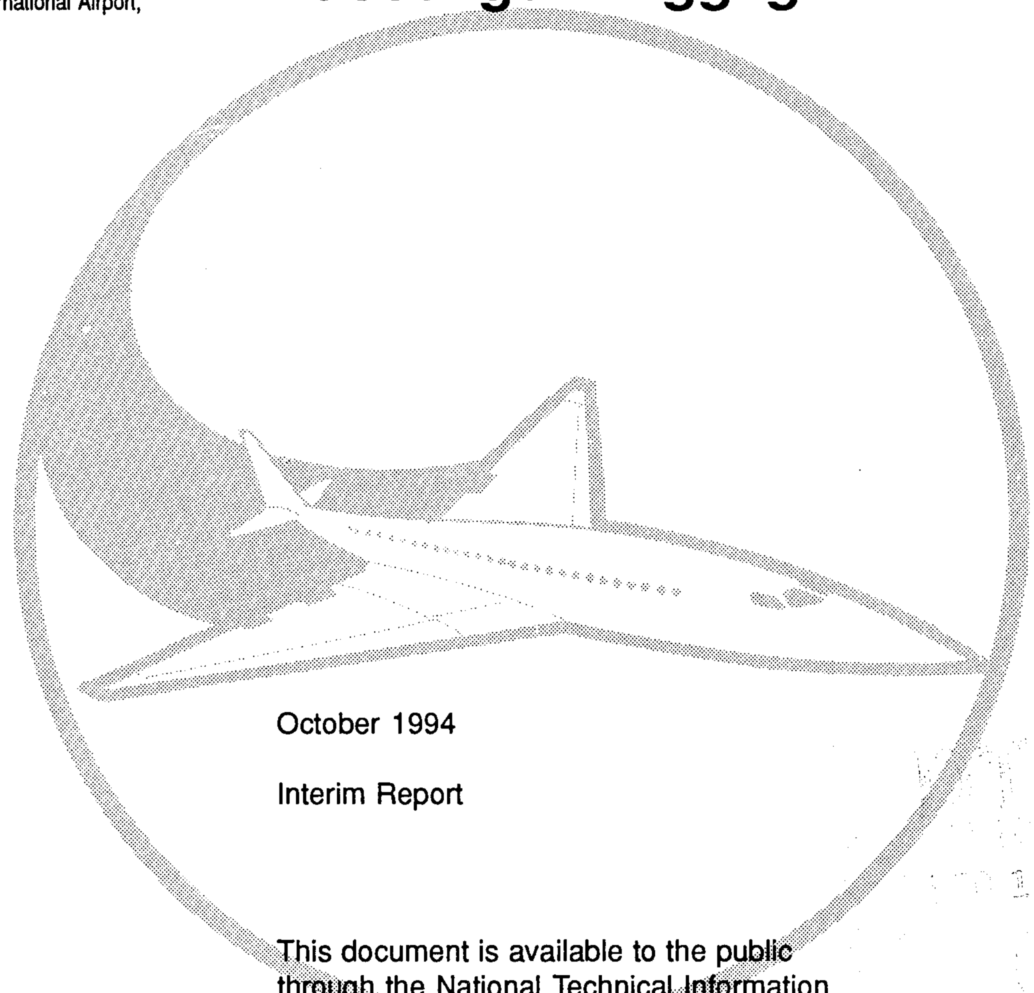
A Protocol for Selecting Airline Passenger Baggage Screeners



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Interim Report

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16. Abstract

This report is the second in a three-part series that describes a research program to improve the selection and retention of airline passenger pre-board screener personnel. This document details the methodology used to conduct a job task analysis of the X-ray position. The job task analysis was conducted to provide guidance in the selection and development of potential predictor instruments. The task analysis appears to indicate a number of cognitive and perceptual abilities that may be related to successful target detection. Specifically, perceptual abilities encompassing the constructs of flexibility of closure, speed of closure, perceptual speed, field dependence-independence, and pattern recognition may contribute to the acquisition of relevant information while scanning X-ray images. Higher level cognitive processes involved in decision making and attentional resources encompassed by the construct of vigilance appear to be required for successful screener performance as well. These psychological qualities are important for the role they play in analyzing and attending to the relevant input. Together with the assessment of appropriate personality traits, the incorporation of perceptual and cognitive assessment instruments has the potential to establish a useful personnel selection system.

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TABLE OF CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

This report is the second in a three-part series that describes a research program to improve the selection and retention of airline passenger pre-board screener personnel. This document details the methodology used to conduct a job task analysis of the X-ray position. The job task analysis was conducted to provide guidance in the selection and development of potential predictor instruments.

The reader is directed to the first report for an examination of the literature related to the selection and performance measurement issues. Issues related to job tenure, job satisfiers and dissatisfiers, and recommendations to reduce employee turnover can be found in the final report of the series.

1. INTRODUCTION.

A widely accepted technique in use today to determine the aptitude dimensions that are needed within a valid selection system are to conduct a thorough job task analysis (JTA). The task analysis should be complete enough to provide sufficient detail as to all task elements and subtasks required of the job. Task elements should define all actions, decisions, receipts and requests for information, and communication links involved within the position. The level of specification should permit an evaluation of the information processing, cognitive, perceptual, and psychomotor abilities required to perform each task element. Identification of the requisite information processing abilities provides the foundation of appropriate selection models.

A task analysis however, while defining all task elements, does not necessarily describe a set order of functions that all operators rigidly engage. A task analysis does not imply that all operators perform all the indicated task elements. The task analysis simply represents all given task elements that are possible functions of a specific job. This is particularly pertinent with respect to the X-ray scanning position for airline passenger security screeners. The image displayed on the monitor is a complex visual field that can be analyzed and interpreted using several visual characteristics. For example, aspects of the visual field may be analyzed for visual characteristics defined by size, shape, or density. The decision reached by the operator on the next course of action is dependent upon whether certain criteria are met or not met for that characteristic. The objective of conducting this JTA is to identify all task elements and decisions that are required for successful target detection.

The number of characteristics that are analyzed by screeners may vary considerably in detecting targets. The amount of information used by a screener may well define the effectiveness or quality of performance for the X-ray scanning position. The focus of the analysis is to determine what visual characteristics, or types of information, are used by screeners while on task. The analysis was also conducted to determine if there are differences among screeners in the type or quantity of information used in analyzing each image. We also sought to determine how critical each display characteristic was in the screening process. Several facilities have been included in the analysis to ensure generalizability with regard to equipment, security contractor, and geographic area. A secondary goal of the task analysis was to examine the relationship between experience and the type of information used in screening all items entering the sterile area.

2 METHODOLOGY AND RESULTS.

2.1 PHASE I.

Phase I of the JTA was conducted at Orlando International Airport (MCO) to develop a functional flow analysis of the X-ray scanning position. The flow analysis was undertaken to identify all task elements, decision points, actions, and activities related to the position. An operations-decision approach (Jonassen, Hannum, and Tessma, 1989; Meister, 1989) was used to complete this work.

The functional flow analysis data was generated using a number of techniques: (a) training, (b) observation, (c) incumbent interviews, (d) supervisor and instructor interviews, and (e) hands-on operation of the X-ray equipment. This methodology allowed for ensuring that all task elements of the position were discretely identified. Utilization of these techniques also permitted sequencing the required functions of the screening process.

Three investigators completed the FAA/ATA airline passenger security screening curriculum to formal certification. Two investigators continued to "work the position" beyond certification as security team members. During the training and certification process all elements of the X-ray screening task were demonstrated and practiced. This gave the research investigators an opportunity to identify task elements in a structured training environment. In addition, it was possible to isolate many of the decision points involved in the process, while acquiring an understanding of the X-ray display characteristics that had to be identified and analyzed. The training and certification process required 7-8 days to complete (including mandated State of Florida Class D Security Officer Certification).

In conjunction with training, screeners were observed and interviewed on-line to identify additional cues, procedures, actions, decisions, and display characteristics that were used while on position. This process further extended the breath of the functional flow analysis and offered an environment to identify strategies used in the screening process. Observing and interviewing screeners also provided further structure to the analysis by defining the typical flow of activities and actions that were required in the operational environment. Extensions and additions to the flow analysis that were obtained from screeners were verified with supervisory and instructional personnel. In most cases these additional task elements were not included in the training program and were expected to be acquired through job experience.

The completion of Phase I resulted in the construction of the functional flow diagram shown in appendix A. This diagram depicts all possible activities and decision chains for the X-ray screening position during the normal work shift. While clearly defining the task elements required for target detection and screening, it does not represent the position as performed by all personnel. The X-ray display characteristics that are examined, and the alternative actions chosen by each screener are partly individualized. The functional flow diagram only captures all probable task elements that are inherent in the position and offer a working model for the task analysis.

2.2 PHASE II.

This component of the JTA was conducted to determine: (a) if the functional flow analysis was complete and accurate; (b) if the structure of the flow analysis was generalizable to airport checkpoints operated by a different security firm; (c) the number of X-ray display characteristics used by screeners in analyzing carry-on items; and (d) the scan patterns used by screeners.

All Phase II work was carried out at Fort Lauderdale International Airport (FLL) over a two-day period. Investigators observed and interviewed screeners on-line at two different security checkpoints. Three work shifts were observed. Most of the screeners were observed for two 30-

minute shifts. In all, 15 screeners (all available personnel working the X-ray position during the site visit) were observed and interviewed. Job longevity ranged from 3 to 75 months with a mean time on job of 26.9 months (Median = 13.9 months). Job longevity for this site was uncharacteristically long as compared to the rest of the industry (note that this is not a representative sample of the national workforce).

A simple data collection instrument was developed to assist with the observation and interview process (see appendix B). Items within the instrument were not presented verbatim to the screeners but were instead queried in reference to specific visual characteristics of the X-ray display. For example, if a specific item or area caused the screener to examine the carry-on closely (e.g., stop the belt, call for a bag check, confer with a supervisor, have the carry-on re-entered for a second pass through the X-ray devices, etc.), the investigators questioned the screener as to the characteristics of the image that caused concern (i.e., size, shape, density). During the interview the investigators also queried the screener as to the importance or significance of those characteristics in identifying targets or the items in question. The evaluative component was limited to a high, medium, or low assessment. This same approach was also used when the screeners passed carry-ons through the X-ray machine without incident. In these instances screeners were queried what components or characteristics were missing that resulted in a "pass" decision.

A secondary objective of this phase was to determine if screeners used a standardized scan pattern when viewing the X-ray display. This was typically done while an image remained on the display, but while no further carry-ons were entering the X-ray device. Screeners were asked to demonstrate their scan pattern by tracing the pattern with their hand on the display. Investigators would verify these responses by observing the eye movements during further screening operations.

Regarding the nature of the scan patterns, we found that screeners develop scans that are highly individualized. Although the scan patterns were individualized, two major techniques were apparent. Some screeners would scan from the entry side to the exit side of the display (right to left or left to right dependent on the position of the checkpoint with reference to the non-sterile passenger area) while scanning from top to bottom. The second major scan pattern would move from entry to exit side, but instead alternated with directed attention to darker areas of the image. Scan patterns were not taught as part of the training regime.

The functional flow analysis developed from the MCO-based data accurately and completely described the X-ray screener position at the FLL security checkpoints. In fact, no additional task elements or task characteristics emerged. Consequently the working model appeared valid and no revision was required.

The most important facet of this phase was to ascertain the relative importance, and distribution of use, of X-ray display characteristics among screeners. This phase of the work was also used to refine the interview process and re-develop data collection instruments for the follow-on phases of the task analysis. Our findings indicated that the most important display characteristics for identifying carry-on contents were: (a) size of items, (b) the size of opaque areas that might mask other contents, (c) shading or impenetrability of the X-ray (represented by color), (d) presence of components that might be assembled to construct incendiary or explosive devices, and (e) shape or form of present images. Of less significance were: (a) angle objects appear (only 40 percent of the sample indicated they mentally rotate questionable objects to reach decisions); (b) degree of clutter or amount of material in the carry-on; and (c) presence of items such as photographic equipment, computers, flashlights, toy weapons, and scissors. Knives and tools were scrutinized dependent on quantity and size.

These data warranted the examination of display features used by screeners at other security checkpoint facilities. Although the Phase II work identified all the display characteristics used by screeners in identifying targets, it did not clearly show the differences among screeners with regard to the number of parameters used in the process. It was primarily instrumental in assessing the importance of various display characteristics. It is possible that the number of characteristics employed in the screening process reflects the depth of analysis conducted. We believe the depth of analysis used, as reflected by the number of characteristics analyzed, may provide a measure of the effectiveness of screener performance.

2.3 PHASE III.

Phase III was conducted solely to determine if differences exist among screeners with respect to the number of X-ray display characteristics used in the screening process. The objective of this work was to assess if screeners are different in the depth of analysis they conduct while screening. These data provide a measure of how representative the functional flow analysis is in describing the depth of analysis portion of the X-ray screening task.

The work was carried out at six security checkpoints at Newark International Airport (EWR) and New York's John F. Kennedy International Airport (JFK) over a four-day period. EWR was selected upon recommendation of the primary security contractor as representing a facility where substantial differences among screeners could be observed in screening performance. This facility, as a result of vast differences in the various checkpoints with regard to task difficulty level, assigns screeners based on observed job performance. In short, the most capable screeners are assigned to the most difficult concourses generally characterized by the amount of passenger activity and other peripheral problems (e.g., baggage theft). This management technique also provided an opportunity to discuss with supervisory personnel those performance elements that were used to distinguish screeners. JFK represents an additional facility in the same metropolitan area, but operated by a different security organization. This afforded the opportunity to compare screeners from two organizations within the same geographic area at comparable airports.

As previously done, a simple data collection instrument, based on the functional flow analysis and the work carried out at FLL, was used to record job performance. The instrument was basically dichotomous in nature, allowing investigators only to indicate whether or not a screener used a display dimension in screening carry-ons. The instrument is presented in appendix B. Three investigators, all trained in the screening process, conducted the work. Investigators would observe and interview incumbents on-line. Supervisory personnel were interviewed off-line to determine the performance elements used to evaluate screener personnel.

Eighty-one (81) airline passenger security screeners operating the X-ray position were observed. The job longevity of this sample ranged from 2-72 months with an average time on job of 19.8 months (EWR: $\underline{M} = 14.1$, $s = 12.3$; JFK: $\underline{M} = 25.8$, $s = 22.7$). Of the total sample ($N = 81$), 32 screeners were male (40 percent) and 49 were female (60 percent).

Phase III data are reported by perceived order of importance in table 1 below. There were no significant differences found between the two airports. The data clearly demonstrate that there are individual differences among screeners with regard to the number of display characteristics used in the screening process. In particular, a sub-sample of the population tends to use all available information in the screening process. We also found that some screeners would rely only on a few display characteristics while on position. These individuals clearly have a narrow range of perceptual features incorporated into their scan pattern, which substantially reduces the level of analysis conducted on each item.

TABLE 1. RESPONSES OBTAINED FROM INTERVIEWS WITH SECURITY SCREENERS (N = 81)

Display Dimension(s)	Number of Responses	
	Yes (percent)	No (percent)
Impenetrability of the object (density)	79 (98%)	2 (2%)
Shape or Form of the image	76 (94%)	5 (6%)
Large area of Opaque Shading or Masking	71 (90%)	8 (10%)
Size of questionable area	65 (80%)	16 (20%)
Presence of Possible Components (wires, batteries, clocks, bottles)	59 (74%)	21 (26%)
Profile or Angle of object:		
Is it important to see the object from the side, top, or other angle?	59 (74%)	21 (26%)
Do you mentally rotate the object when necessary?	43 (54%)	37 (46%)
Amount of Clutter in bag	52 (66%)	27 (34%)
Do any of the following require a bag check?		
Toy Guns	75 (100%)	0
Computers	31 (44%)	40 (56%)
Flashlights	16 (24%)	50 (76%)
Any other factors you look for not mentioned?	4 (14%)	24 (86%)

3. DISCUSSION.

In conducting the JTA and developing the functional flow analysis, 96 screeners were observed in the performance of the X-ray screening process. Performance differences among screeners, within and between facilities, were striking. Particularly outstanding performance was observed among some screeners who were adept at identifying both test targets (FAA, security firm, airline) and unplanned possible threat items (passenger carried). Our identification of outstanding screeners was consistent with checkpoint security supervisor and station manager evaluations.

In one specific incident a screener had detected the presence of an opened bottle, several batteries, a timing device, and wiring not associated with the internal components of electronic devices. These items, taken together, could conceivably represent components of an incendiary device. Recognition of this carry-on as a possible threat required substantial depth in cognitive processing, numerous decisions, isolation and identification of key components in a complex visual field, and understanding the dynamics of threatening devices. Consistent with the model developed from the functional flow analysis, this individual analyzed the contents of the carry-on along several domains. This incident was characteristic of many such "bag checks" that resulted in identifying non-permissible items.

Screeners who performed the X-ray screening process at a high level of competency were found to analyze an extensive array of display characteristics. In other words, superior performers were representative of the decision process depicted in the functional flow analysis. In contrast, screeners who were marginal performers lacked a comprehensive decision process. The less proficient screeners would characteristically analyze X-ray images using a limited number of display characteristics. Generally, such performance was characterized by requesting bag checks only when an object was impenetrable and/or the shape was similar to one of the FAA test items. Although this limited analysis of the X-ray image was sufficient for passing airline, security firm and FAA checks, it was not adequate to identify actual potential threats. It appears that these less proficient screeners only look for the FAA test items and learn how to recognize them through repetition. Actual potential threats may not match the shape of FAA test items, nor may they be detected on the basis of X-ray impenetrability alone. Effective security screening relies on the identification and analysis of carry-on contents, not pattern recognition of a few test items.

The depth of the analysis, or number of levels that decisions are made during the screening process, appears to be the single-most important criteria in discriminating screener performance. This is not to imply that trait factors (i.e., motivation, teamwork, personality factors) do not influence performance. The results from the task analysis and observations however indicate that screener performance is related to ability in the decision-making process. Vigilance alone, as an ability, is therefore not likely to predict screener performance. Although vigilance is required to perceive the relevant inputs, clearly some level of information processing is necessary to identify targets. Display characteristics have to be analyzed along several domains for effective identification.

The extensiveness of the decision-making process, as represented by the functional flow analysis diagram, can be observed in relationship to time. This is particularly true for screeners who perform the task efficiently. Display images that are "clean" and featureless (e.g., garment bag containing only cloth items), are quickly screened and almost never require stopping the belt for closer analysis. The screening process is comparatively fast as no display characteristics are present as input to the decision process. Differences in performance between effective and marginal screeners are not discernible with such images as the decision-making process is only made along one level (impenetrability of X-ray).

There were however, numerous incidents observed when the screeners would begin the image analysis and detect a potential threat. It was observed and verified by questioning that the screener could not identify the contents displayed on the X-ray image, or the image was opaque, or was too difficult to "read." The screeners recognized that a potential threat could exist but failed to call a bag check. Several occasions were observed when a laptop computer, portable telecommunications device, or a large flashlight (all examples of possible threats) were passed through and the screener did not initiate the required bag check. The reason(s) for the screeners' lack of appropriate actions are not clear, however there was one plausible factor that may have influenced their judgment. When screeners called for a bag check during peak traffic times, and that request resulted in a false alarm, the supervisor on duty often became irritated and expressed their disappointment with the action taken. One specific example was observed where the screener recognized a potential threat in a carry-on bag. The bag clearly had an opaque item that required further investigation because it could have easily contained a potentially dangerous object. The screener called the supervisor over to administer a bag check. The supervisor briefly scanned the X-rayed image and replied with a sour expression, "Come on, that does not need to be checked." Such management practices discouraged screeners from taking the initiative to examine all potential threats.

As the complexity of the display image increases, the amount of time required to analyze the image consequently increases. This is expected since the number of objects within the display increases. However, based on the on-line interviews with screeners, the more efficient screeners will also evaluate the contents along a greater number of display characteristics. This consequently results in longer time durations in evaluating the image and rendering a decision. Superior screeners conduct this level of analysis to identify any contents that may potentially constitute a threat.

The relationship between image complexity and time was not as evident with less proficient screeners. Moderately and extremely complex images would require more time than featureless images, but were processed in a shorter time in comparison to superior screeners. On-line interviews indicated that such screeners would only evaluate the image along a few display characteristics. The decision process in many cases would only evaluate the characteristics of impenetrability, size, and shape. Unlike the performance of superior screeners, less proficient screeners were less capable of identifying the majority of contents in an item being X-rayed.

A limited decision model among less proficient screeners was also observed to impact the number of bag checks. Less proficient screeners were not capable of identifying objects since most of their analysis included only features of impenetrability or shape. This limited analysis, and the resulting incapability of identifying objects from an X-ray image, consequently caused an increased number of bag checks or Checkpoint Security Supervisor (CSS) approval to "clear" the bags. In one particular case this initiated a bag check on over 50 percent of the carry-ons. The screener focused exclusively on the feature of impenetrability. Any carry-on that contained items the X-ray could not penetrate generated a bag check. The vast majority of these bag checks were unnecessary had a further analysis been conducted. To illustrate, many bag checks could have been eliminated had display features of shape and size been included in the screener's decision model. Several carry-ons were bag-checked simply because of the presence of a few coins.

Using a limited decision model could possibly represent a strategy to reduce task demands to a manageable level. This approach diminishes the efficiency of the screening process while not making available the full capability of the X-ray hardware. Effective screening requires perceiving all inputs made available by the existing hardware and basing decisions on the fullest range of information. Some security screening personnel may not have the ability to process information to the level required within the time constraints imposed by the equipment.

Perhaps the number of display characteristics used in analyzing X-ray images is directly related to the perceptual speed of the screener. As previously pointed out, the screening process occurs at a relatively constant speed predicated by the equipment. Those individuals who can very rapidly scan a visual image and compare it to specific mental references possess the capacity to incorporate a more extensive array of display characteristics. Screeners that are not as proficient with regards to perceptual speed may compensate by reducing the amount of information scanned from each display image. As such, perceptual speed may impact target detection performance by modulating the amount and depth of information extracted by screeners in scanning X-ray images. Strong consideration should be directed at marker tests for the assessment of perceptual speed as a potential predictive tool.

The discussion of airline passenger security screener abilities has focused thus far on the information processing abilities after an image has been perceived. The JTA clearly highlighted differences among screeners with regard to the decision models used. However, equally important are the cognitive/perceptual abilities required in X-ray security screening. Possible directions for the evaluation of individual differences that may relate to screener performance include: (a) vigilance measures, (b) pattern recognition and related constructs, and (c) disembedding figure from background perception.

Vigilance, as a theoretical construct, has been presented in detail in the introduction with findings from experimental studies. Our purpose here is to explore the applications of laboratory findings to the work environment. In the airport security checkpoint environment the application of vigilance is of concern in two respects. Maintenance of vigilance on the display monitor is required to ensure that no carry-on passes without inspection. A high degree of vigilance is further required for each carry-on to conduct a threat analysis. Maintenance of vigilance in this low signal to noise environment, under varying conditions of ambient noise, temperature, and lighting, presents a highly demanding task. The workload is farther complicated by not having a temporal expectancy of the signal, and by the range of signals possible. This environment requires that an individual is capable of maintaining a high degree of vigilance while disregarding irrelevant environmental distracters. As previously stated however, simply maintaining vigilance is necessary only to the extent of perception. The inputs perceived from an image still require processing to determine the presence of threats. From a selection prospective, any valid selection battery will require assessing an individual's vigilance ability under high workload and distracting conditions.

An integral component of the workload in security screening is the time demand component. The detection and analysis of threats occur in a dynamic environment where the workload is dependent upon passenger flow through the checkpoint. This creates an environment where the number of carry-ons per unit time varies widely. Of primary concern are those situations where there is a constant demand for screening. Such circumstances require screener personnel to acquire inputs from a moving visual field, perceive and isolate relevant inputs, and quickly choose an appropriate action. This continuous cycle of perception and information processing again highlights the need to select individuals capable of sustaining vigilance under high and varying workload conditions.

The tasks involved in X-ray security screening procedures also warrants the consideration of an assessment of pattern recognition. Successful detection of threats, and efficiency in the screening of carry-ons, is predicated on the need to rapidly categorize objects as constituting threats, non-threatening items, and hazardous materials. The speed and efficiency of X-ray screening are obviously enhanced by recognizing familiar patterns that do not constitute items of concern and eliminating them from further consideration.

Highly competent screeners were noted to identify non-targets in each image rapidly and easily. Most of these identifications were achieved by simple pattern recognition. Pattern recognition in this environment was characterized by identifying objects from different perspectives and in varying rotations. During most of the on-line observations/interviews screeners were queried as to the identity of specific objects and the angle of view or rotation the object was seen from. The capability to perform this operation requires understanding the perspective generated by the individual X-ray device (image depiction differs among devices), and then mentally generating an object's position relative to its position in the carry-on. Pattern recognition is required for both target and non-threat item detection.

Our analysis indicated that shape was a primary display feature used by nearly all screeners. The emphasis on pattern recognition was also evident in training video tapes, on-line training, and security firm initiated checks. An important technique used in X-ray security screening was to familiarize screeners with the shapes of potential threats (i.e., FAA targets) from several perspectives with the expectation of recognizing actual targets when they occur. The underlying assumption was that threats can be recognized by training personnel to respond to one specific target, with the expectation that pattern recognition will generalize across the entire threat category. For example, screeners are typically only trained on a small sample of handguns. It was expected that specific features of handguns will contribute to recognizing all members of that threat classification, regardless of the profile of the weapon.

Pattern recognition is also required under conditions where the object may be partially obscured by other items in the carry-on. Pattern recognition under such adverse conditions had to be accomplished from only partial images. Pattern recognition as an attribute required for successful performance in security screening was demonstrated in the task analysis. Assessment of pattern recognition capability is warranted in a selection battery designed to hire X-ray security screeners. However, special consideration should be devoted to developing instruments that assess pattern recognition under conditions where only partial information or cues are available to identify an object.

Possible tests for inclusion should assess the cognitive factor of speed of closure. The Gestalt Completion Test and the Snowy Pictures Test (Ekstrom, French, Harman, and Dermen, 1976) appear on the surface to be similar to the tasks involved in X-ray screening. That is, both instruments measure the ability to detect objects that are embedded, and possibly obscured by the background. Past research (Crumley, Pierce, Schwalm, Coke, and Brown, 1992) has indicated that speed of closure may be related to the detection of targets within a complex visual image. Instruments that assess speed of closure may be promising for predicting performance because of their apparent similarity to the X-ray scanning process.

An evaluation of the relationship between field dependence-independence and screening performance should also be explored. Field dependence-independence is a measure of an individual's ability to disembed figures from ground relationships. Although much controversy surrounds the nature of this construct since first introduced by Witkin (1950), there is some face validity in applying this concept to screener performance.

The task of the X-ray screener is after all disembedding objects (targets) from a complex visual field (carry-on items). Screeners are required to identify materials from images under conditions of few visual cues from a background visual field that may obscure or mask the objects being searched for. The Embedded Figures Test (EFT) or Group Embedded Figures Test (GEFT), both developed by Witkin (1971), purports to assess this specific ability. These instruments may potentially predict screener performance and warrant an investigation of their predictive validity.

Whether the instruments developed by Witkin (1971) assess a particular personality trait or evaluate a unique construct related to spatial ability is a theoretical issue that is of little importance for purposes of personnel selection. This is the focus of the current controversy surrounding field dependence-independence. Our concern is the relationship of this construct to success as an X-ray screener.

Similar tests from the Kit of Factor-Referenced Cognitive Tests (Ekstrom et al., 1976) measure the cognitive factor of flexibility of closure (i.e., Hidden Figures and Hidden Pattern Tests) and may also have the potential as predictive instruments. Both tests are similar to the EFT and GEFT in that they provide a measure of the ability to detect specific shapes or patterns within a complex visual field. These instruments appear related to the perceptual tasks involved in detecting weapons of a known shape or pattern in a carry-on item. These marker tests for flexibility of closure are similar to X-ray screening as they require identification of target items in a visual field by comparison with mental images. An examination of these instruments' relationships to X-ray screening performance appears worthwhile.

In summary, the results from the JTA appear to indicate a number of cognitive and perceptual abilities that may be related to successful target detection. Specifically, perceptual abilities encompassing the constructs of flexibility of closure, speed of closure, perceptual speed, field dependence-independence, and pattern recognition may contribute to the acquisition of relevant information while scanning X-ray images. Higher level cognitive processes involved in decision making and attentional resources encompassed by the construct of vigilance appear to be required for successful screener performance as well. These psychological qualities are important for the role they play in analyzing and attending to the relevant input. Together with the assessment of appropriate personality traits, the incorporation of perceptual and cognitive assessment instruments has the potential to establish a useful personnel selection system.

As put forth earlier, there may be some personality traits related to screener success. Several personality traits were in fact referred to by supervisory and management personnel during the JTA work as important for success as a screener. Personality traits were often referred to as the "soft" side of screener requirements.

The JTA was not oriented toward identifying related personality traits. This is not the purpose, nor appropriate methodology, for gathering these data. However, given the potential utility of assessing personality traits for predicting performance, and some of the earlier findings (ATA, 1990) that indicate possible relationships, these issues will be examined during the next phase of the investigation. Delphi small-group workshops with screeners and supervisory personnel provides a suitable format to explore these concepts

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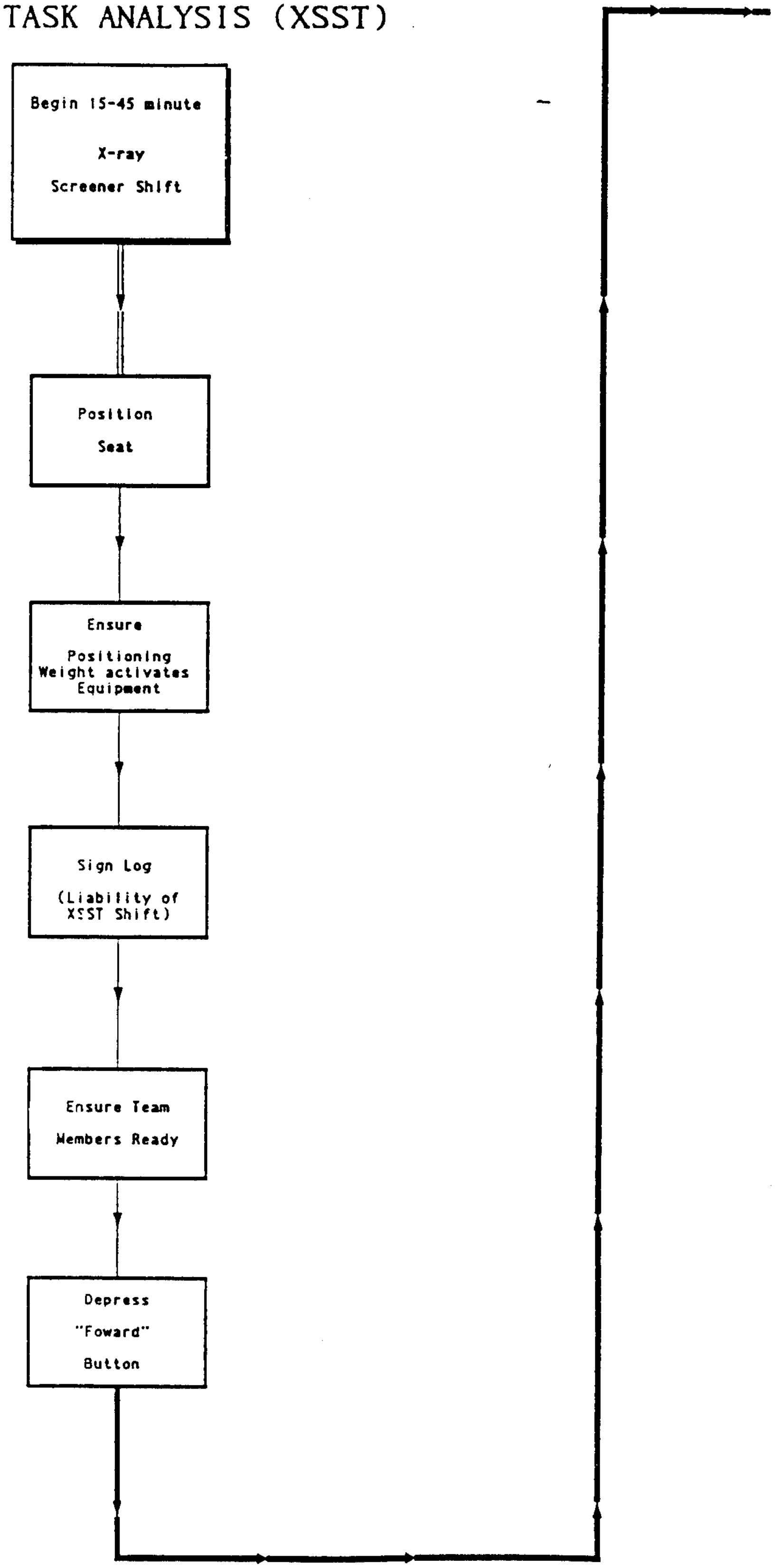
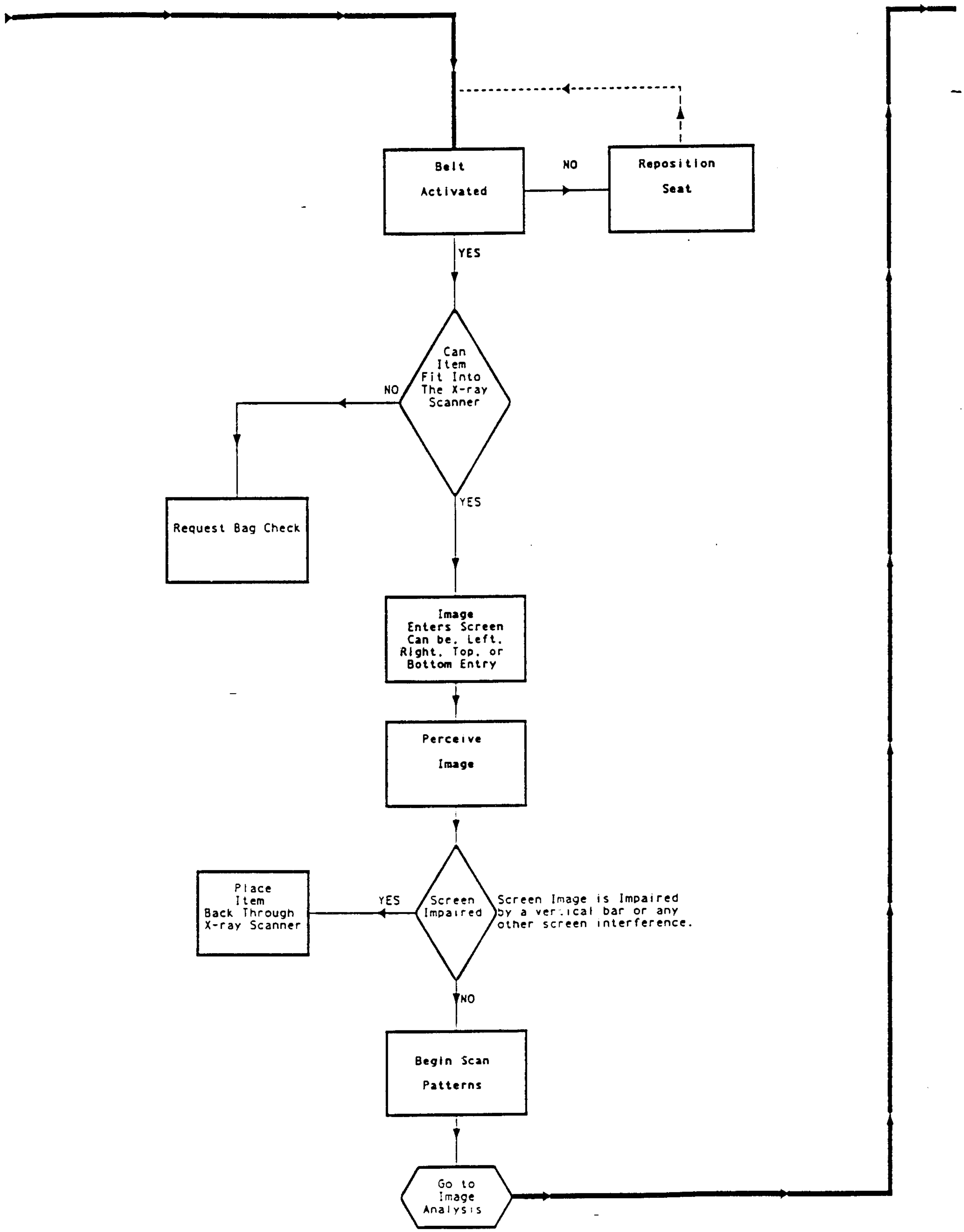
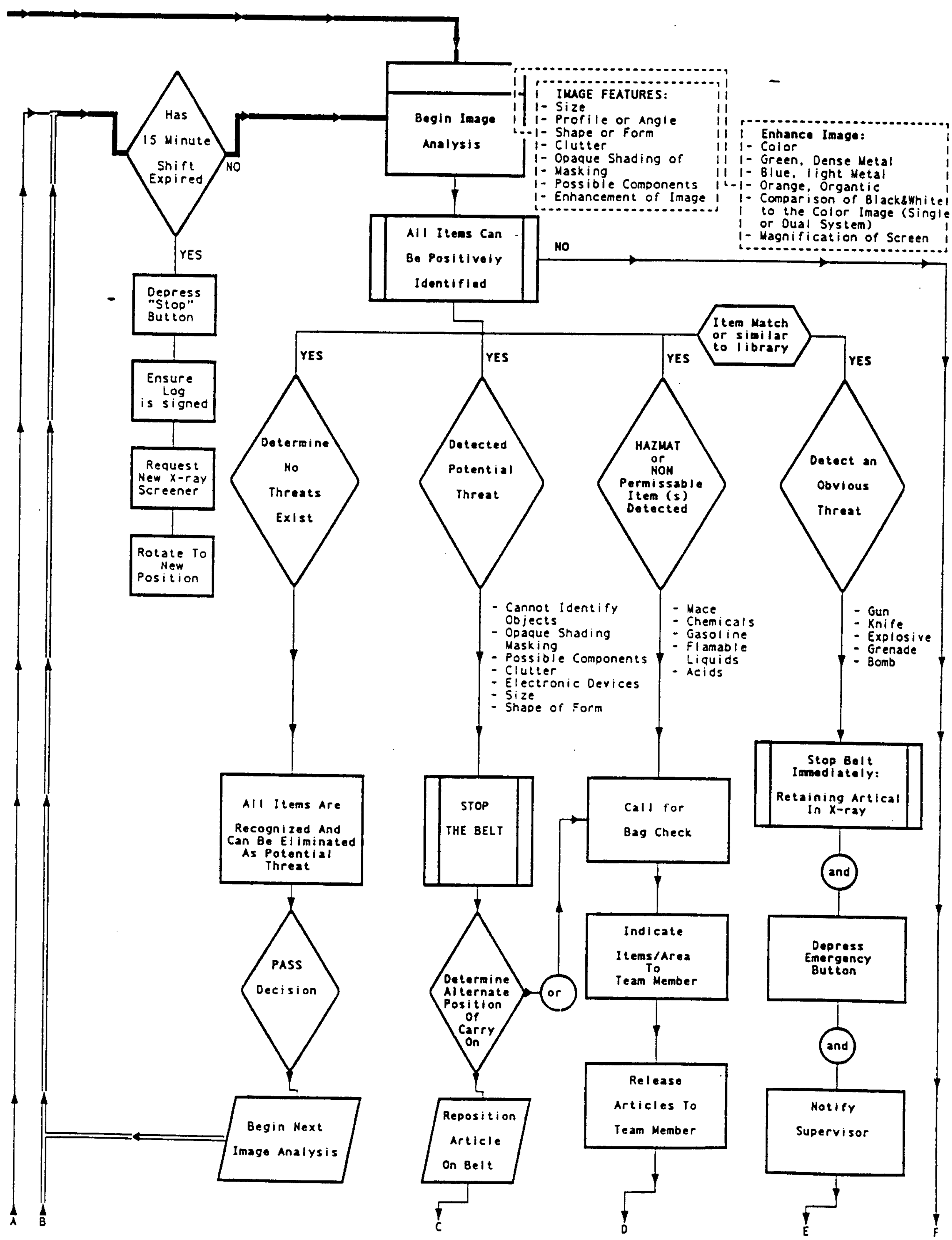
APPENDIX A

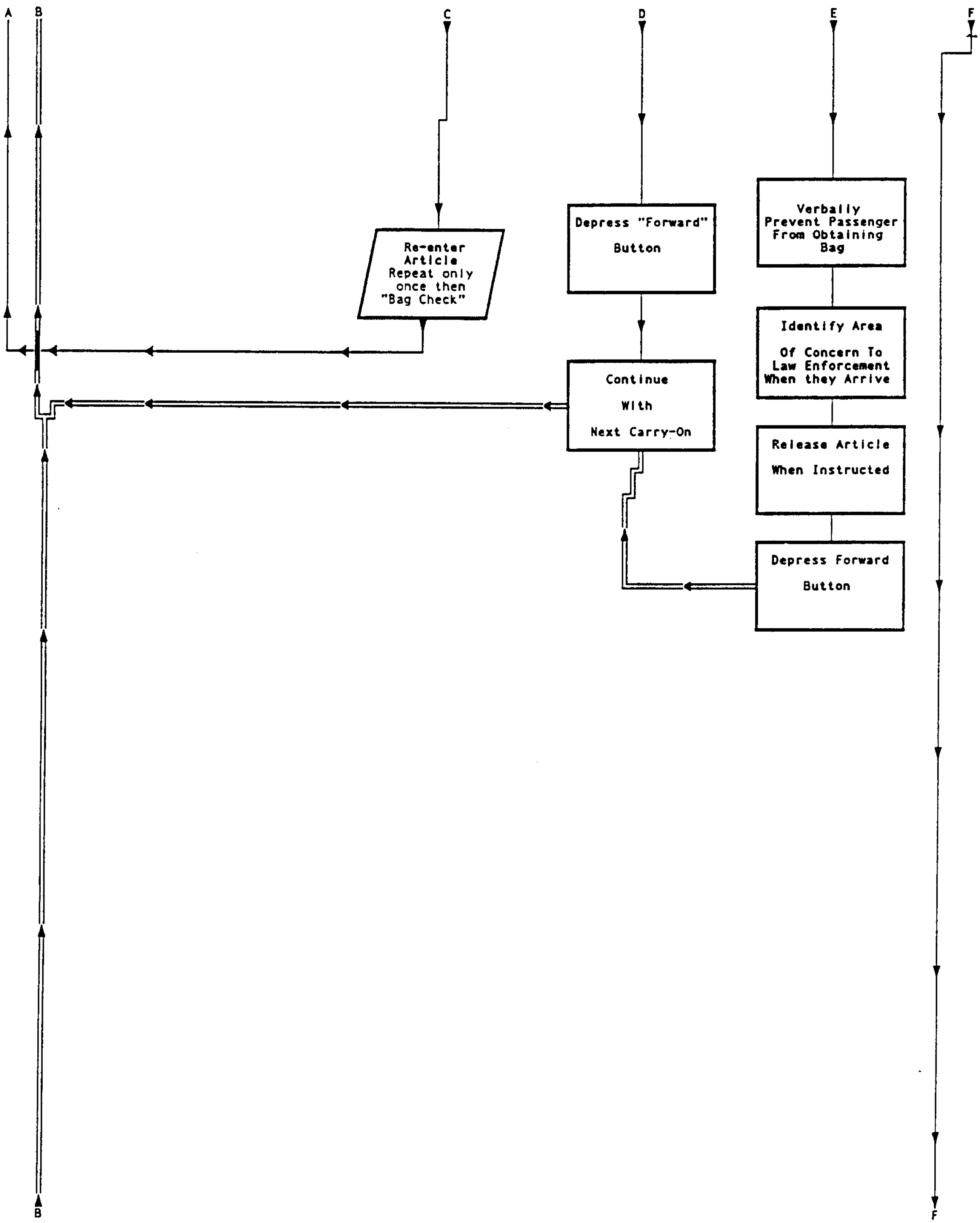
JOB TASK ANALYSIS FUNCTIONAL FLOW DIAGRAM

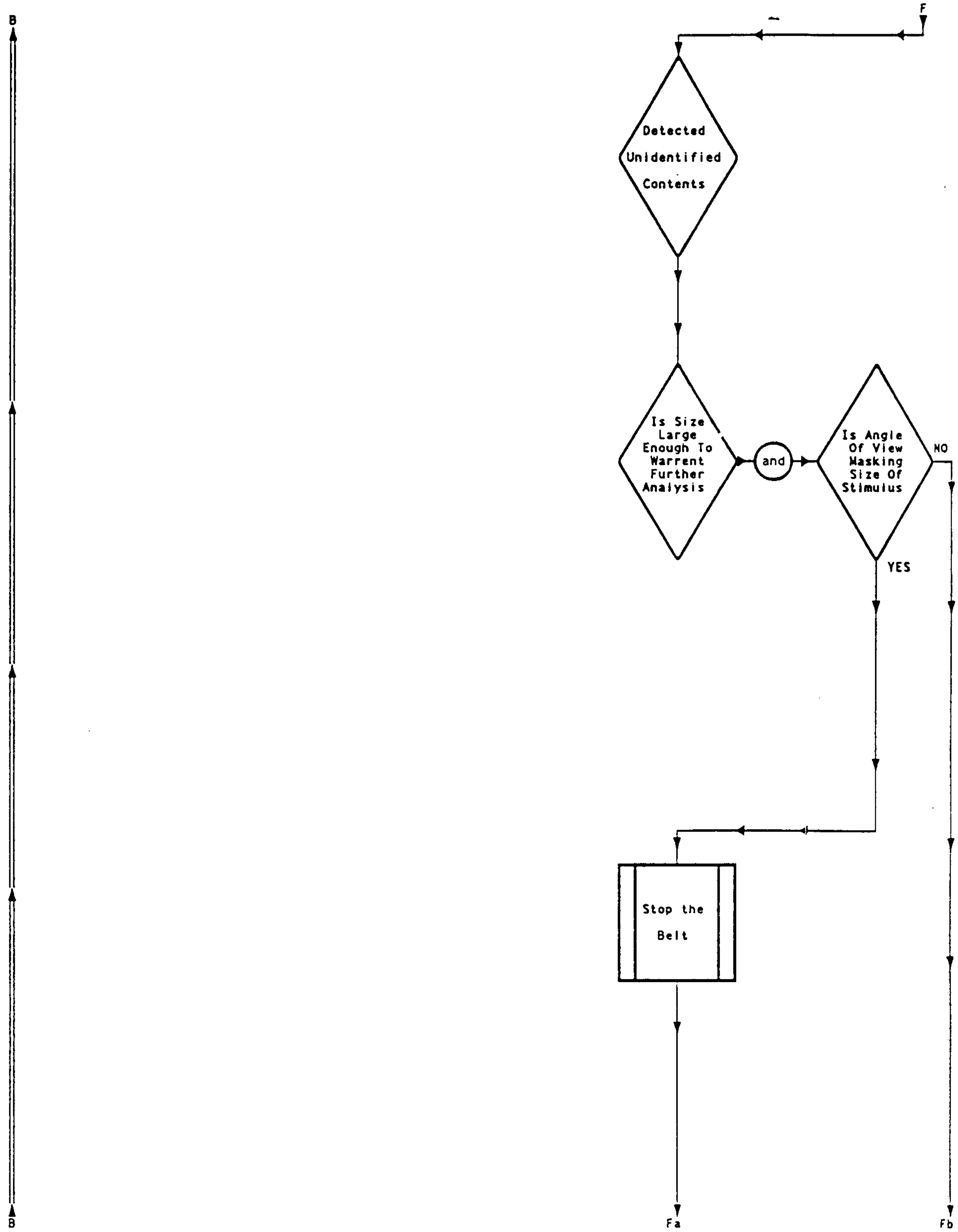
JOB TASK ANALYSIS (XSST)

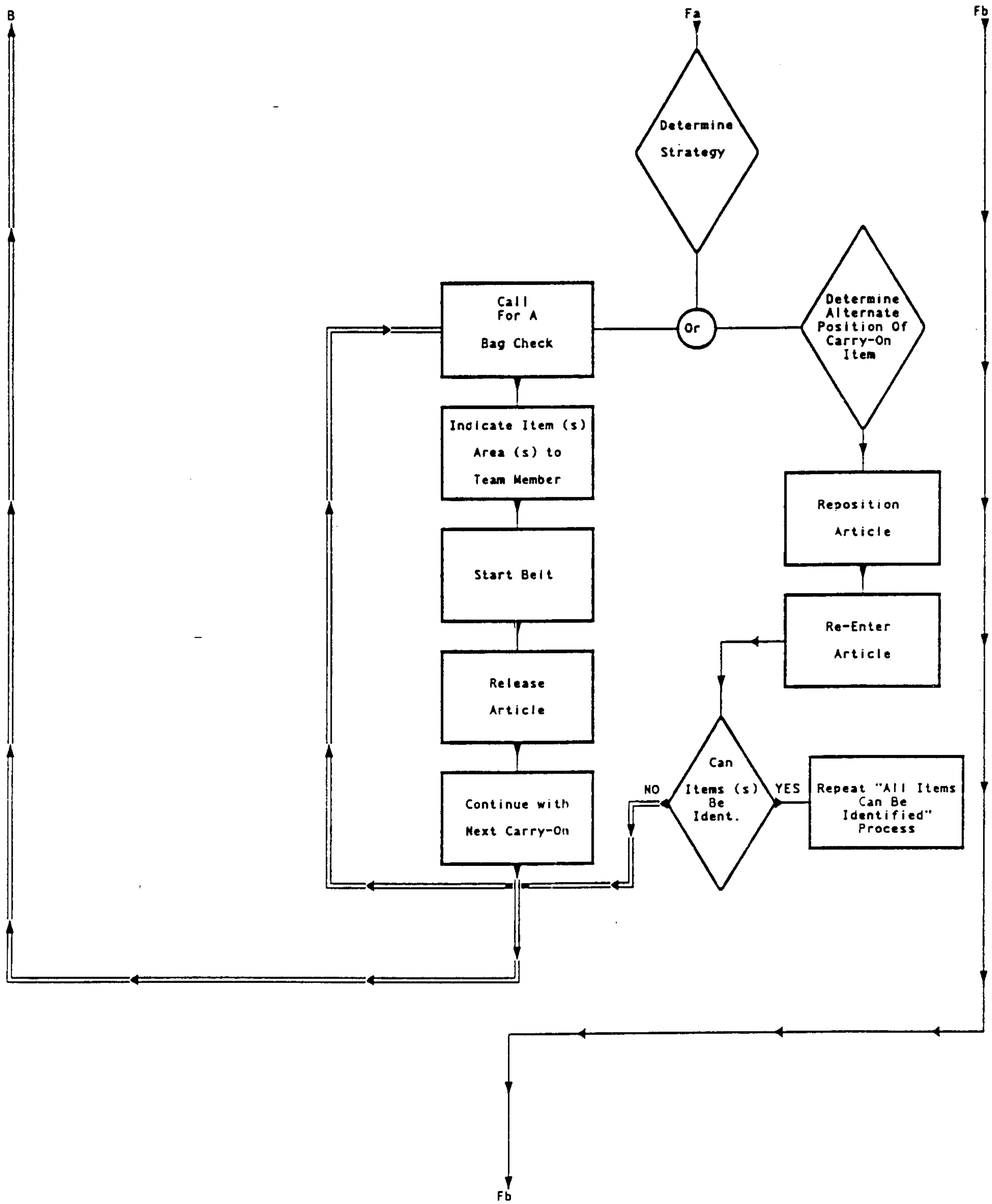



Belt
Activated
NO
Reposition
Seat
YES
Can
Item
Fit Into
The X-ray
Scanner
NO
Request Bag Check
YES
Image
Enters Screen
Can be. Left.
Right. Top. or
Bottom Entry
Perceive
Image
Place
Item
Back Through
X-ray Scanner
YES
Screen
Impaired
Screen Image is Impaired
by a vertical bar or any
other screen interference.
NO
Begin Scan
Patterns
Go to
Image
Analysis

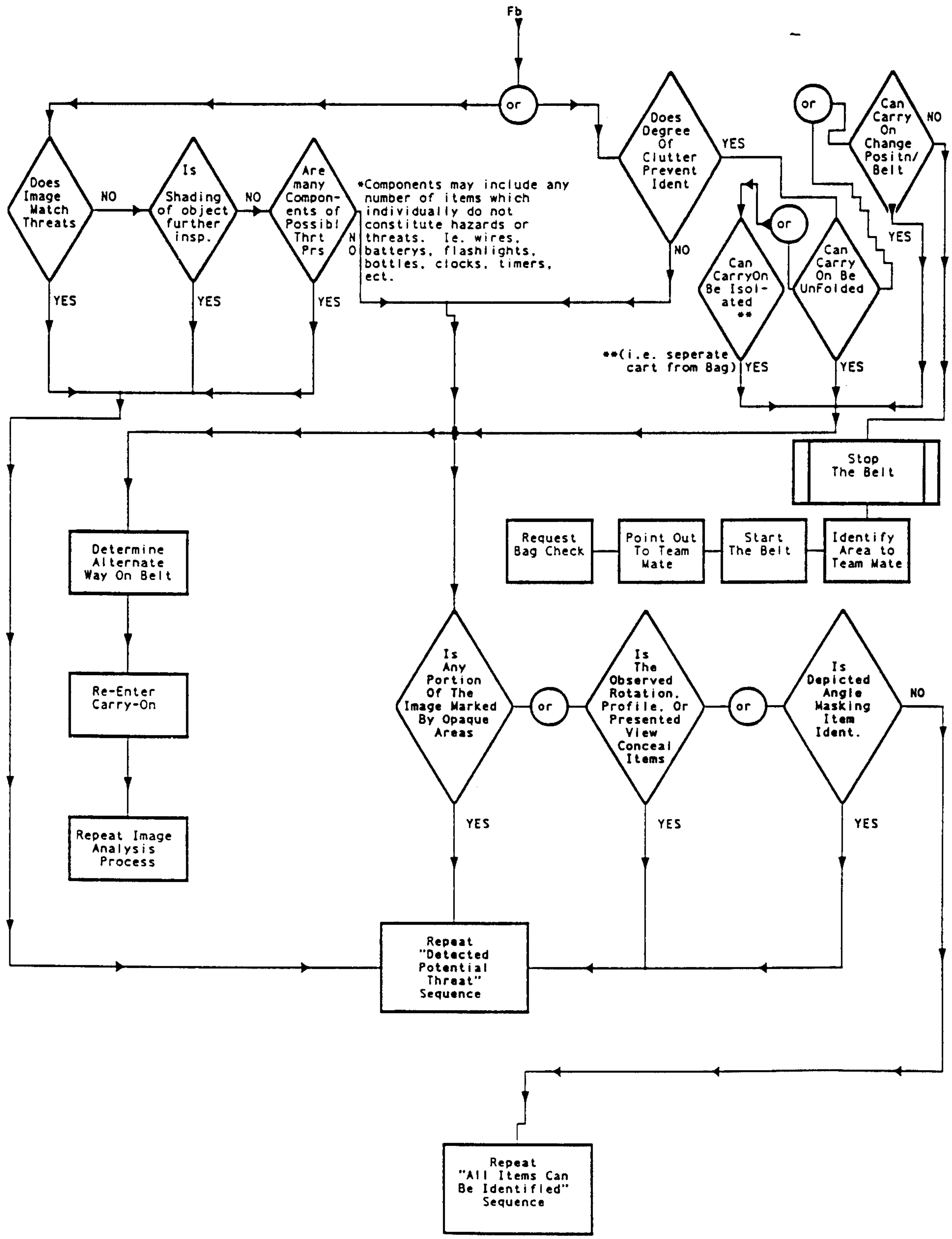

Has 15 Minute Shift Expired
NO
YES
Depress "Stop" Button
Ensure Log is signed
Request New X-ray Screener
Rotate To New Position
Begin Image Analysis
IMAGE FEATURES:
- Size
- Profile or Angle
- Shape or Form
- Clutter
- Opaque Shading of
- Masking
- Possible Components
- Enhancement of Image
Enhance Image:
- Color
- Green, Dense Metal
- Blue, light Metal
- Orange, Organtic
- Comparison of Black&White to the Color Image (Single or Dual System)
- Magnification of Screen
All Items Can Be Positively Identified
NO
Item Match or similar to library
YES
Determine No Threats Exist
Detected Potential Threat
HAZMAT or NON Permissable Item (s) Detected
Detect an Obvious Threat
- Cannot Identify Objects
- Opaque Shading Masking
- Possible Components
- Clutter
- Electronic Devices
- Size
- Shape of Form
- Mace
- Chemicals
- Gasoline
- Flamable Liquids
- Acids
- Gun
- Knife
- Explosive
- Grenade
- Bomb
All Items Are Recognized And Can Be Eliminated As Potential Threat
STOP THE BELT
Call for Bag Check
Stop Belt Immediately: Retaining Artical In X-ray
PASS Decision
Determine Alternate Position Of Carry On
or
Indicate Items/Area To Team Member
and
Depress Emergency Button
and
Begin Next Image Analysis
Reposition Article On Belt
Release Articles To Team Member
Notify Supervisor
A
B
C
D
E
F


A
B
C
D
E
F
Re-enter Article Repeat only once then "Bag Check"
Depress "Forward" Button
Continue With Next Carry-On
Verbally Prevent Passenger From Obtaining Bag
Identify Area Of Concern To Law Enforcement When they Arrive
Release Article When Instructed
Depress Forward Button
B
F


B
F
Detected Unidentified Contents
Is Size Large Enough To Warrent Further Analysis
and
Is Angle Of View Masking Size Of Stimulus
NO
YES
Stop the Belt
B
Fa
Fb



B
Fa
Fb
Determine Strategy
Call For A Bag Check
Or
Determine Alternate Position Of Carry-On Item
Indicate Item (s) Area (s) to Team Member
Start Belt
Release Article
Continue with Next Carry-On
Reposition Article
Re-Enter Article
Can Items (s) Be Ident.
NO
YES
Repeat "All Items Can Be Identified" Process
Fb



Fb
or
Does Image Match Threats
NO
Is Shading of object further insp.
NO
Are many Components of Possibl Thrt Prs
NO
YES
YES
YES
*Components may include any number of items which individually do not constitute hazards or threats. Ie. wires, batterys, flashlights, bottles, clocks, timers, ect.
Does Degree Of Clutter Prevent Ident
YES
NO
or
Can Carry On Change Positn/ Belt
NO
YES
or
Can CarryOn Be Isol- ated **
Can Carry On Be UnFolded
**(i.e. seperate cart from Bag)
YES
YES
Stop The Belt
Request Bag Check
Point Out To Team Mate
Start The Belt
Identify Area to Team Mate
Determine Alternate Way On Belt
Re-Enter Carry-On
Repeat Image Analysis Process
Is Any Portion Of The Image Marked By Opaque Areas
or
Is The Observed Rotation, Profile, Or Presented View Conceal Items
or
Is Depicted Angle Masking Item Ident.
NO
YES
YES
YES
Repeat "Detected Potential Threat" Sequence
Repeat "All Items Can Be Identified" Sequence

APPENDIX B

JOB TASK ANALYSIS OBSERVATION/INTERVIEW FORM

JOB TASK ANALYSIS

FACTORS IN THE DECISION TREE/ANALYSIS:

Image appears on screen . . . can positive identification be made or not?
1) No threats 2) Potential threats 3) Obvious threats 4) Hazmats/not permissibles

If not . . . decision process questions:

1. Is the size large enough to be considered further?

2. Is the pattern/shape/form match possible problems?
If yes . . . is it real (gun) or not (toy) by further analysis?

3. Is the color (shading)/impenetrability indicative of further analysis?

4. Are components (wires, fluids, batteries, etc.) present to warrant further analysis?

5. Can known or recognized objects be eliminated?

6. Is any portion of the image masked by opaqueness?

7. Can the object be required to undergo further analysis if seen rotated (compact), profiled, or bird's eye view?

8. Is depicted angle masking identity?

9. Does stimulus match known library of targets? (trained images) question of generalizability?

MISCELLANEOUS:

Is scan pattern in totality, individualized, right to left, etc.?

ACTIONS:

1. Re-enter carry-on through X-ray at different angle and repeat decision process

2. Hand search

3. OPD and initiate emergency procedures

4. Pass

JOB TASK ANALYSIS

VERBAL PROBES:

1. Critical cue probes: Verbally probe screener as to those cues that result in detailed examination. Specifically identify characteristics. Particular attention to actions where bag check, re-analysis, or belt motion is halted. Identify features (cues) that are used.

2. Goal alternate decision/action paths: Determine decision and action paths for target identification. Identify specific decision points and flow of decision logic.

3. Causal factor analysis: Acquire data on cues used that are not present in the image (i.e., passenger appearance, passenger flow rate, disposition of passenger, etc.). Identify factors that change/alter the nature of the bag scan/screen.

4. Hypothetical probes: Use verbal probes to phrase "what if" scenarios. Determine and clarify cues and characteristics used in screening images.

5. Decision option assessments: Determine cues and characteristics that result in differing decisions and actions. Are there specific cues that lead to specific decisions or actions in a definable trend?

6. Error analysis: Isolate cues or elements that result in "false alarms" or "misses." What did the screener miss that resulted in an error? Were "false alarms" provided performance feedback, i.e., physically shown object.

7. Direct observation with cognitive probes: Ascertain, by using structured (data recording form) or semi-structured interviews, those cues and decision points the screener uses while an image is still on the monitor. Accomplish during training sessions, proficiency checks, periods of slow traffic, during bag checks, and air carrier checks. Use test items in various rotations and obscurity to present an image on the monitor. Ensure screener physically identifies cues in response to cognitive probes. Determine depth of screening examination and extent of the number of cues.

PHASE II: SCREENER (X-RAY POSITION) TASK ANALYSIS

1. Query the nature of scan (top-down, center outward, right-left, etc.); i.e., technique for viewing image or movement of eyes around screen.

2. Importance of, or degree of uncertainty for these factors (rated simply as E, H, M, L). This is to determine how important each of these are in a pass, stop, bag check, re-X-ray decision. Whether to do something with the "bag" or not.

a. Size of questionable area

b. Angle object appears. Rotation or profile of certain objects creating uncertainty (side view, top view)

c. Shape or form of image (outline)

d. Degree of clutter of image (overpacked carry-on)

e. Large area of opaque masking contents within (can't see objects because something blocks view)

f. Are questionable items rotated mentally to make decision

g. Shading, impenetrability of X-ray, or color of object

h. Presence of possible components that together would constitute a possible threat such as *wires*, *batteries*, *clocks*, *timers*, *bottles*, etc.

I. Computers, printers, stacks of paper

j. Flashlights

k. Guns that are clearly no threat (toy guns), plastic handles, etc.

l. Other aspects that cause uncertainty or concern (itemize)

PHASE III: SCREENER TASK ANALYSIS (X-RAY POSITION)

1. Number of months in the position: ________________

2. Determine whether or not the following factors are a consideration in identifying items. Simply put, are these factors used or not used in a pass, bag check, re-X-ray decision. Whether to do something with the bag or not. Positive or negative response is all that is needed. Frequency or routineness of using factor is not an issue here.

a. Size of questionable area: ________

b. Profile or angle object is laying in carry-on: _______
i.e., Is it important that the object may be seen from the side, the top view, or at an unusual angle?

b.2. Do you attempt to figure out what the object may be by trying to mentally see it in your head from different viewpoints?
We are trying to determine if screeners mentally rotate: _________

c. Shape or form of the image, it's outline: _________

d. The amount of clutter the carry-on appears: ___________
In other words, if the carry-on is especially cluttered, do you do anything different or special?

e. Large area of shading or masking which blocks view of contents of the bag. Can't quite determine what's in the carry-on: ______________

f. The impenetrability of the X-ray, i.e., dark coloring of object: ________

g. Is the presence of possible components (i.e., wires, batteries, clocks, timers, bottles) considered or cause for bag check: __________

3. Do any of the following items factor in a resulting bag check or closer observation:

* Flashlights :____
* Computers :____
* Toy Guns :____

4. Are there any other factors or items that cause concern or you look for?