Guide 5

FINDING EVENT BLOCKS WITH ENERGY TRACE AND BARRIER ANALYSES

During MES-Based Investigations

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FINDING EBs WITH ETBA

A continuing challenge to incident investigators is trying to find data to transform into Event Blocks (EBS.) Energy Trace and Barrier Analysis (ETBA) is a technique for tracking energys ources and flows through a

system during the process, and observing where they do workand what work they do, and transforming that into EBs.
The general ETBA method is to

1. identify energies going into and acting within the system
2. track each energy and its actions in the system
3. identify the barriers and controls acting on the energies
4. define the effects of the energy actions
5. transform the actions into EBs

Procedures for this technique are contained in this Guide.

INTRODUCTION

The Energy Trace and Barrier Analysis (ETBA) method can be used to develop a more detailed understanding of energy exchanges that occurred during a phenomenon. The technique helps investigators avoid oversights in behaviors that might not otherwise be noticed.

This technique approaches the development of Event Building Blocks (EBs) by tracing the flows of energy into, within, and out of a system or component involved in a phenomenon. It is based upon the premises that energy flows introduce changes in a system or component which, if understood, can be predicted and controlled. ETBA documents energy flows by methodically tracing energy movements within systems or components, and across interfaces, to identify behaviors that influenced the course of events being investigated.

OBJECTIVE

The objective of this Guide is to present the procedure used to identify energies involved in a phenomenon, document them for use on MES Matrixes, and define additional data requirements.

APPLICABILITY

ETBA can be used at any stage of an investigation to explore changes and help develop hypotheses about what might have happened.

DATA REQUIRED

The procedure can accommodate any observed or documented data about energies involved in any occurrence. It requires knowledge about about energies, their attributes and behaviors; the energies present during an occurrence; the expected course of the energy flow through the system involved with the occurrence; and the energy flow out of the system.

DATA SOURCES

The procedure uses

1. an energy source checklist (see Table 5-2)

2. any observed or documented data from any source that describes or indicates energy sources or energy flows.

Where data are acquired from things, inferences about the presence of energy sources and flows are usually acceptable.

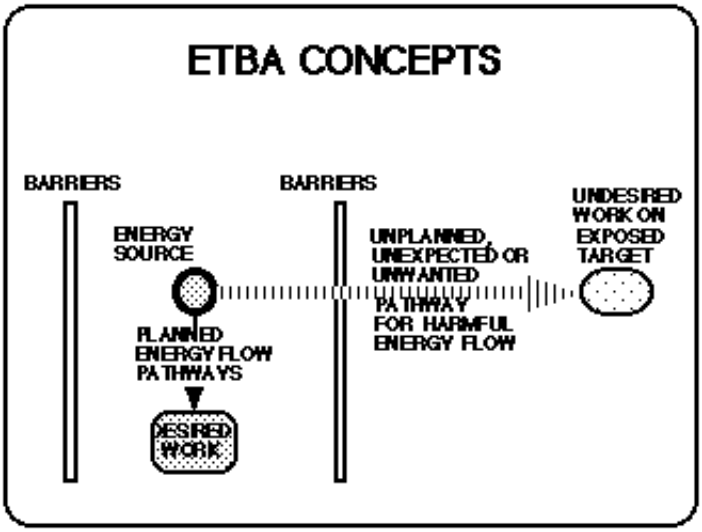
Each type of energy, summarized in Table 5-2, may need to be considered individually from the perspective of the phenomenon being investigated if it is present during the process. Energies present also need to be considered in the context of any energy control strategy or strategies that may exist (See Guide 8.) The operation needs to be analyzed at the input /use /output level for each energy type to determine if energy barriers or controls address realistic potential control problems and satisfactorily control them.

ETBA requires detailed familiarity with the operation or system. ETBA often requires the services of someone who really knows the operation and who can trace energies and barriers /controls thoroughly.

ETBA PROCEDURE

The ETBA procedure relies on *input-operation-output* analytical thought processes. Someone or something introduces energy into the phenomenon being investigated (input.) After it is introduced, the energy does something in the system (operation.) After it does something in the system (output) , left over energy may exit the system (output.) If the interaction(s) required all the energy available, it may leave behind evidence of its interactions. The residual effects of energy exchanges may be recorded as changes in things or on recordings of measurement devices, or as observations by people of motion or displacement, for example. These are the "tracks" that must be observed before EBs can be developed for an MES Matrix.

Figure 5-1 Energy Flows and Barrier Roles



After identifying an energy source that was present or introduced into the system, and where it is present in the system, the procedure is to trace what the energy did or does during the phenomenon of interest. This requires identification of the "targets" of energy flows for each energy source. For each energy type, the flow must be traced to each transfer or use point, and then traced into any branches that flow from that point. Then each physical or procedural barrier to the energy must be considered to determine what changes occurred or might occur. When occurrences are being investigated, ETBA helps define EBs by asking certain questions about each energy type. Figure 5-2 is a list of those thought starter questions.

Figure 5-2 ETBA Checklist

ETBA CHANGE ANALYSIS CHECKLIST	
Energy Flow Changes	Changes in Barriers
1 Flow too much/too little/none at all	1 Barrier too strong/too weak
2 Flow too soon/too late/not at all	2 Barrier designed wrong
3 Flow too fast/too slowly	3 Barrier too soon/too late
4 Flow blocked/built up/released	4 Barrier degraded/failed completely
5 Wrong form/wrong type input or flow	5 Barrier impeded flow/enhanced flow
6 Cascading effects of release	6 Wrong barrier type selected

For an undesired outcome to occur, there must be an energy source with a released flow of energy to a target in the absence of adequate barriers. The flow or transfer of energy follows some path between the energy source and the target or component of the operation being protected.

Remember: the objective is to develop EBs, where the energy is the actor, what the energy did is the action, and what the energy acted on is included in the descriptor. The descriptor for an energy flow EB should include the pathway.

COMMENTS

ETBA is one of the most practical and informative investigation tools available to investigators. It is essential when applying deductive reasoning to observations of objects to discover the actions which changed them during a phenomennon. The mental discipline required to trace the energy flow and the results produced by energy flows during a phenomenon can be demanding, but the rewards from its use are usually so great that the effort justifies it. The main precaution is to ensure that the data are converted into the EB format to allow integration with other data provided by other investigation tools.

This framework can also be used for analyzing human energy inputs, and tracing the pathway followed by human energy initiation. In a hand injury, for example, the ETBA method can provide very useful EBs for Matrixess by tracking the energy inputs, barriers, energy flows, and resultant injury.

ETBA is also very helpful for investigation of occurrences before they occur. Figure 5-3 describes the procedure for using it for investigations. The first step, defining the system operation, can utilize the MES Matrix method for displaying who or what does what to produce the desire outputs during system operations. The the ETBA procedure can be applied to the system operation to discover potential mishaps.

Figure 5-3 ETBA Procedure Flow Chart

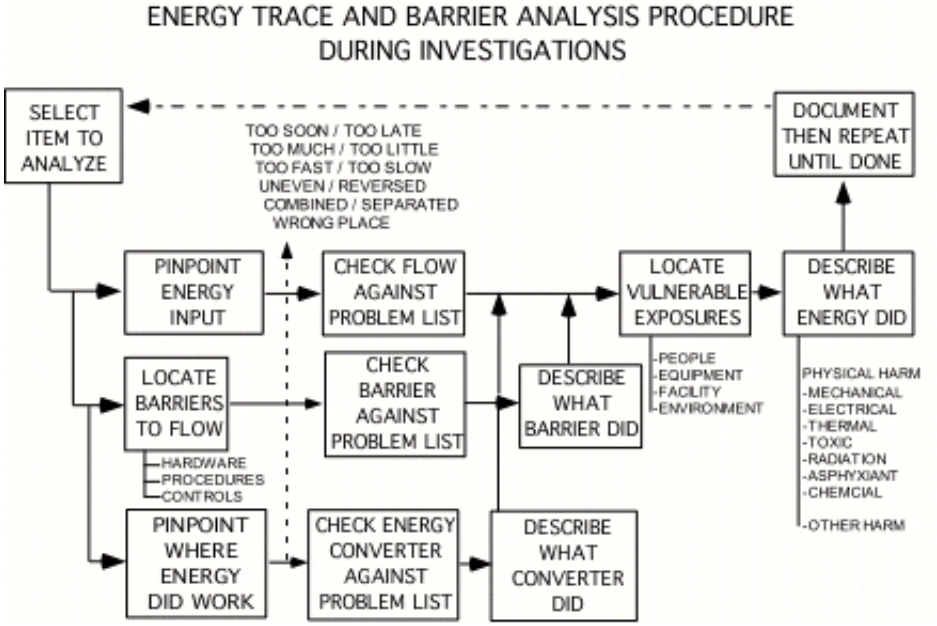


Figure 5-4 ENERGY TRACE AND BARRIER ANALYSIS
ENERGY TYPE CHECKSHEET

○ INPUT ENERGY PRESENT	□ ENERGY TRACED THROUGH SYSTEM
(1) [ ] ELECTRICAL	(8) [ ] CHEMICAL (acute and chronic sources)
○ □ ac or dc current flows	○ □ anesthetic / asphyxiant
○ □ stored electrical energy / discharges	○ □ corrosive
○ □ electromagnetic emissions / RF pulses	○ □ dissolving / solvent / lubricating
○ □ induced voltages / currents	○ □ decomposable / degradable
○ □ control voltages / currents	○ □ deposited materials / residues
	○ □ detonable
(2) [ ] MASS / GRAVITY / HEIGHT (MGH)	○ □ oxidizing / combustible / pyrophoric
○ □ trips and falls	○ □ monomer / polymerizable
○ □ falling / dropped objects	○ □ chemical toxin / embryotoxin
○ □ suspended objects	○ □ waste / mixture (air / land / water)
	○ □ water reactive

(3) [ ] ROTATIONAL KINETIC	(9) [ ] THERMAL
○ □ rotating machinery / gears / wheels	○ □ radiant / burning / molten
○ □ moving fan / propeller blades	○ □ conductive
(4) [ ] PRESSURE / VOLUME / KINETIC DISPLACEMENT (P / V / KD)	○ □ convective / turbulent
	○ □ evaporative / expansive heatg / coolg
○ □ overpressure ruptures / explosions	○ □ thermal cycling
○ □ vacuum growth	○ □ cryogenic
○ □ liquid spill / flood / buoyancy	
○ □ expanding fluids / fluid jets	(10) [ ] ETIOLOGIC AGENTS
○ □ uncoiling object	○ □ viral
○ □ ventilating air movement	○ □ bacterial
○ □ trenching / digging / earth moving	○ □ fungal
	○ □ parasitic
(5) [ ] LINEAR KINETIC	○ □ biological toxins
○ □ projectiles, missiles / aircraft in flt	
○ □ rams, belts, moving parts	(11) [ ] RADIATION
○ □ shears, presses	○ □ ionizing
○ □ vehicle / equipment movement	○ □ non-ionizing / laser
○ □ springs, stressed members	○ □ visible light
(6) [ ] NOISE / VIBRATION	(12) ○ □ MAGNETIC FIELDS
○ □ Noise	
○ □ Vibration	(13) [ ] LIVING CREATURES OR THINGS
	○ □ actions / interactions by people
(7) [ ] DUST	○ □ actions by animals, other species
○ □ Mineral	○ □ actions by trees, shrubs, etc.
○ □ Organic	
○ □ Metallic	(14) ○ □ MOISTURE / HUMIDITY

NATURAL ENERGY SOURCES

(14) [ ] TERRESTRIAL	(15) [ ] ATMOSPHERIC
○ earthquake	○ wind velocity, density, direction
○ floods / drowning	○ rain (warm / cold / freezing)
○ landslide / avalanche	○ snow / hail / sleet
○ subsidence	○ lightning / electrostatic
○ compaction	○ particulates / dusts / aerosols / powders
○ cave-ins	○ sunshine / solar
○ underground water flows	○ acid rain, vapor / gas clouds
○ glacial	○ air (warm / cold / freezing, inversion)
○ volcanic	○ ambient light level

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