"Capacity Building and Strengthening Institutional Arrangement"

Workshop: Quantitative risk assessment of oil and gas plants

APAT Experiences on Tools for Assessing Risks Preventing Accidents

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Italian methodologies for major hazards quantitative risk assessment

Hazards identification in industrial risk assessment

THE RISK IDENTIFICATION METHODOLOGIES MAY BE SUBDIVIDED INTO THE FOLLOWING FOUR CATEGORIES :

- HISTORICAL ANALYSIS
- CHECK LIST
- STRUCTURED TECHNIQUES
- (INDEX TECHNIQUES)

THE HISTORICAL ANALYSIS IS BASED ON THE FOLLOWING SOURCES OF INFORMATION:

- PLANT OPERATING EXPERIENCE
- ACCIDENT DATA BANKS
- SPECIALIZED LITERATURE
- PRESS

THREE DIFFERENT TYPES OF CHECK-LISTS ARE NORMALLY USED:

- GENERAL (CONSISTING IN A WIDE SURVEY OF THE GENERAL PROBLEMS RELATED TO THE SAFETY). THEY MAY BE SUBDIVIDED:
  - FOR EVENTS AT THE BATTERY LIMITS OF THE UNIT BEING EXAMINED
    - CAUSES EXTERNAL TO THE WORKS
    - CAUSES INTERNAL TO THE WORKS
  - FOR EVENTS INTERNAL TO THE UNIT BEING EXAMINED

THE CHECK LISTS BELONGING TO THIS TYPE ARE VERY QUICK TO APPLY, BUT NORMALLY QUITE SHALLOW, AND THEIR USEFULNESS IS CONSEQUENTLY LIMITED.

- DETAILED (FOR INSTANCE, THE ONES PROPOSED BY THE AIChE), DEALING WITH ALL THE SINGLE ASPECTS RELEVANT TO THE SAFETY OF THE PLANT, ITEM BY ITEM, FROM SEVERAL POINTS OF VIEW (DESIGN, OPERATION, MAINTENANCE, ETC.).

CHECK-LISTS OF THIS TYPE MAY BE VERY ONEROUS, AT THE SAME LEVEL OF SOME STRUCTURED TECHNIQUE. AT THE SAME TIME THEY WILL NOT GIVE EQUIVALENT ANALYTICAL AND CREATIVE CAPABILITIES. IN COMPENSATION THEY DO NOT NEED SO A HIGH EXPERIENCE.

- SPECIFIC, DEALING IN GREAT DETAIL SOME PARTICULAR SAFETY FEATURE OR DIRECTED TO A SPECIFIC DISCIPLINE (FIRE FIGHTING, PREVENTION OF ACCIDENTS AT WORK, INSURANCE, ETC.) OR ACTIVITY (AUDITS, INSPECTIONS, COMMISSIONING, ETC.). NORMALLY THEY ARE NOT VERY USEFUL IN THE RISK ASSESSMENT. THEY MAY BE REGARDED MORE PROPERLY AS INSTRUMENTS FOR RISK MANAGEMENT.

NECESSITY OF AN ANALYTICAL AND COMPREHENSIVE ORGANIZATION OF THE LARGE (TO BE HOPED FOR) QUANTITY OF INFORMATION.

A FIRST CLUSTERING TO REDUCE THE IDENTIFIED ACCIDENTS TO POSSIBLE ACCIDENTS:

- CLUSTERING ACCORDING INITIAL EVENTS, ACCIDENTAL SEQUENCES AND TOP EVENTS
- ELIMINATION OF THE HISTORICAL ACCIDENTS NOT APPLICABLE OR NOT CREDIBLE BECAUSE OF THE SITUATION OF THE ACTUAL PLANT

THIS LEVEL OF CLUSTERING CONTRIBUTES TO BUILD UP ACCIDENT FAULT TREES, GIVING THE CONTRIBUTION OF HISTORICAL EXPERIENCE AND CHECK-LISTS (EVENTUALLY TO BE INTEGRATED WITH OTHER CONTRIBUTIONS, SUCH AS FROM STRUCTURED TECHNIQUES)

A SUBDIVISION ACCORDING THE TYPE OF INITIAL EVENT MAY BE USEFUL, AS EACH ONE MAY REQUIRE A DIFFFERENT ASSESSMENT TECHNIQUE IN THE FURTHER PHASES OF THE STUDY:

A. ACCIDENTS DUE TO EXTERNAL NATURAL EVENTS

B. ACCIDENTS DUE TO EXTERNAL ARTIFICIAL EVENTS

C. ACCIDENTS DUE TO RANDOM EVENTS

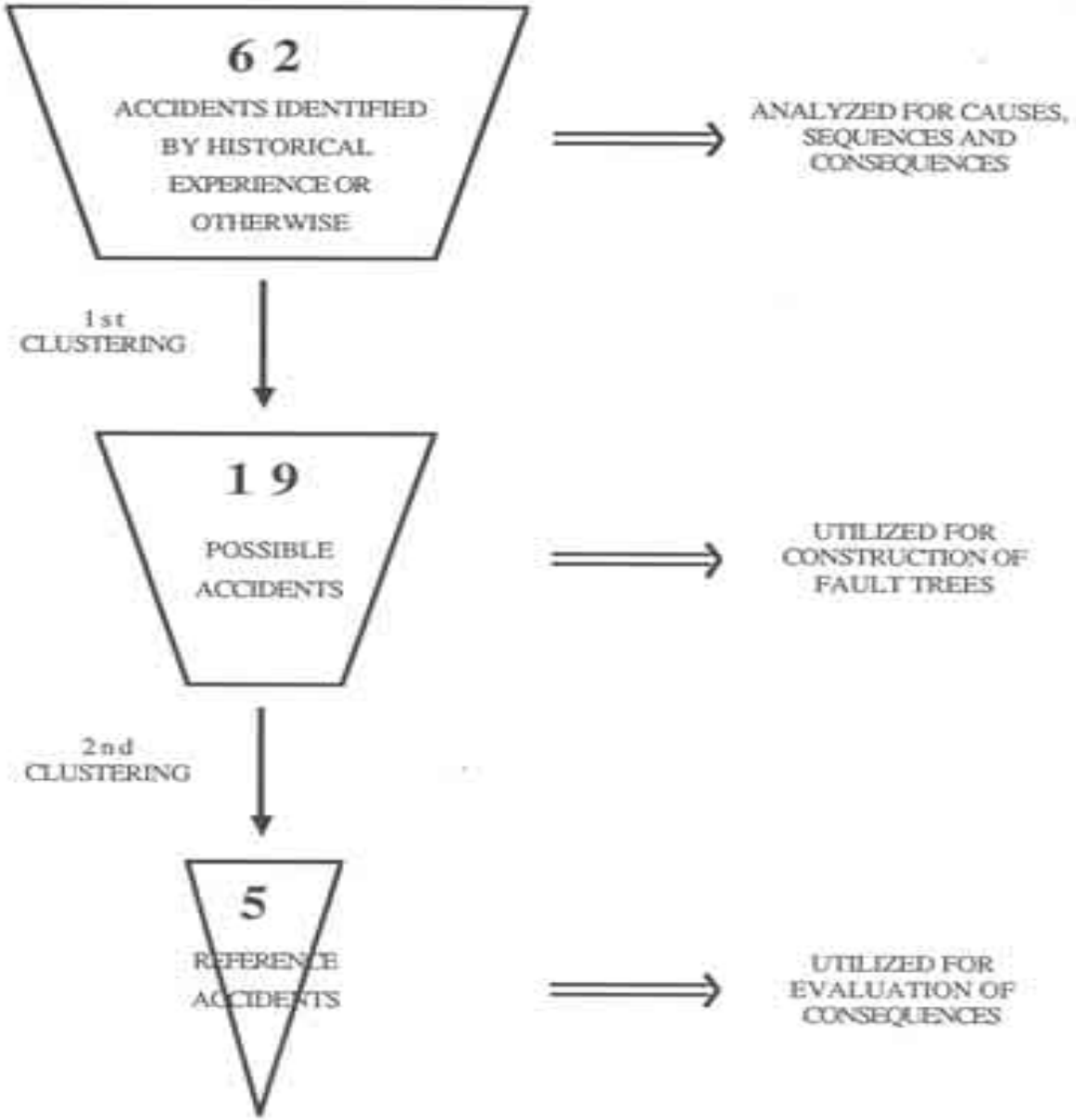
D. ACCIDENTS DUE TO PROCESS CAUSES OR HUMAN FACTORS

A SECOND CLUSTERING TO REDUCE
THE POSSIBLE ACCIDENTS
TO REFERENCE ACCIDENTS:

- CLUSTERING BY TYPOLOGY OF TOP EVENTS,
  UNIFORM BOTH PHENOMENOLOGICALLY
  AND QUANTITATIVELY

THE EVALUATION OF CONSEQUENCES
MAY BE CARRIED OUT LIMITING TO
ANY ONE OF THE REFERENCE ACCIDENTS,
DEFINED AS ABOVE.

AS AN EXAMPLE,
IN THE SAFETY STUDY
OF A REFINERY TANK FARM,
THE FOLLOWING DID RESULT:


6 2
ACCIDENTS IDENTIFIED BY HISTORICAL EXPERIENCE OR OTHERWISE
ANALYZED FOR CAUSES, SEQUENCES AND CONSEQUENCES
1st CLUSTERING
1 9
POSSIBLE ACCIDENTS
UTILIZED FOR CONSTRUCTION OF FAULT TREES
2nd CLUSTERING
5
REFERENCE ACCIDENTS
UTILIZED FOR EVALUATION OF CONSEQUENCES

THE MAIN STRUCTURED TECHNIQUES OF HAZARD IDENTIFICATION ARE:

* HAZOP

(HAZARD AND OPERABILITY STUDY)

* FMECA

(FAILURE MODE, EFFECT AND CRITICALITY ANALYSIS)

BOTH ARE BASING ON THE TYPICAL FRAME OF A PROCESS PLANT, BASED ESSENTIALY ON TWO KIND OF ELEMENTS:

* EQUIPMENT
* PIPING

BASICALLY THEY ACT AS A SORT OF MNEMONIC KEY, TO BE EXTENSIVELY USED IN ORDER TO CENTER THE ATTENTION OF THE ANALYSTS SUCCESSIVELY ON EACH ONE OF THE ELEMENTS FORMING THE PLANT.

THE ADEQUATE APPLICATION OF SUCH TECHNIQUES REQUIRE A DEEP KNOWLEDGE OF THE PROCESS AND THE SPECIFIC FEATURES OF THE PLANT, AND A GREAT EXPERIENCE IN GENERAL ENGINEERING.

THE TECHNIQUES THEMSELVES CANNOT IN ANY WAY MAKE UP THE LACK OF EXPERIENCE OR SPECIFIC KNOWLEDGE.

THE COMPONENTS OF THE TEAM WILL BE, AS A MINIMUM:

* AN EXPERT IN THE APPLICATION OF THE METHODOLOGY
* A PROCESS ENGINEER
* AN EXPERT IN OPERATION/MAINTENANCE
* EVENTUAL SPECIALISTS (PART TIME)

H A Z O P

(HAZard and OPerability study)

ANALYZES THE PLANT
LINE BY LINE,
EQUIPMENT BY EQUIPMENT,
TAKING IN CONSIDERATION
FOR EACH ONE OF THESE ELEMENTS:

* INTENTIONS
* DEVIATIONS
* CAUSES
* CONSEQUENCES
  - SAFETY
  - OPERABILITY
  - PRODUCTION COSTS
  - ETC.

BY APPLYING TO:

* PROCESS CONDITIONS
  - FLOW RATE
  - PRESSURE
  - TEMPERATURE
  - ETC.
* ACTIVITY
* SUBSTANCES
* PHASES

(* TIME)

(* PLACE)

(* REASON)

PRIMARY RESULTS OF A HAZOP ANALYSIS:

* INTERVENTIONS AND MODIFICATIONS TO BE MADE TO INCREASE THE LEVEL OF SAFETY, OPERABILITY, ETC.

* IDENTIFICATION OF THE POSSIBLE ACCIDENTAL EVENTS, TO BE FURTHER ANALYZED IN THE NEXT STEPS.

OTHER POSSIBLE RESULTS:

* INDICATION, FOR ANY ANALYTICAL STEP, OF THE POSSIBLE EVENTS ACTUALLY MEANINGFUL.

* GROUPING OF THE EVENTS, TO SHOW THE POSSIBLE DIFFERENT SEQUENCES LEADING TO A STATED ACCIDENT.

* LOGICAL SYNTHESIS (CLUSTERING) OF THE VARIOUS POSSIBLE ACCIDENTAL SEQUENCES IN ORDER TO ENABLE THE DRAWING OF THE COMPLETE FAULT TREE.

PRELIMINARY HAZARD ANALYSIS (PHA)

- LIST OF RISK TYPOLOGIES
- LIST AND LAY-OUT OF HAZARDOUS SUBSTANCES AND/OR EQUIPMENT, PER EACH TYPOLOGY OF RISK
- ANALYSIS CAUSES/CONSEQUENCES/ ACTIONS

EXAMPLE

RISK:

- RELEASE OF FLAMMABLE MATERIAL
- CONFINED EXPLOSION
- RELEASE OF TOXIC MATERIAL — H_2S, HF, SO_2 — REFER TO TABLE
- RUNAWAY REACTION
- ETC.

COMPARATIVE APPLICATIONS,
TO SHOW THE DIFFERENT COMPLETENESS
THAT THE VARIOUS TECHNIQUES
OF HAZARD IDENTIFICATION
MAY OFFER.

DEPENDING ON THE PERSPECTIVE,
THE RESULTS OF SUCH AN ANALYSIS
MAY DIFFER, AS THREE DIFFERENT
TYPE OF INFORMATION
MAY BE TAKEN INTO ACCOUNT:

- ACCIDENTAL EVENTS
- DEVIATIONS OR INITIATING CAUSES
- CONTROL ACTIONS

AS A GENERAL EXPERIENCE (GAINED IN A NUMBER OF APPLICATIONS):

DEGREE OF COMPLETENESS ACHIEVABLE BY A HAZOP PERFORMED IN DETAIL:
(1-3 DAYS / P&I)

70-80% FOR CONTINUOUS PROCESSES
50-60% FOR BATCH PROCESSES

DEGREE OF COMPLETENESS ACHIEVABLE BY A HAZOP PERFORMED ACCORDING A LOWER STANDARD:
(2-4 HOURS / P&I)

IDENTIFIABLE
2/3 OF ACCIDENTAL EVENTS
1/3 OF DEVIATIONS AND ACTIONS
WITH RESPECT TO THE ONES OBTAINED BY A DETAILED HAZOP.