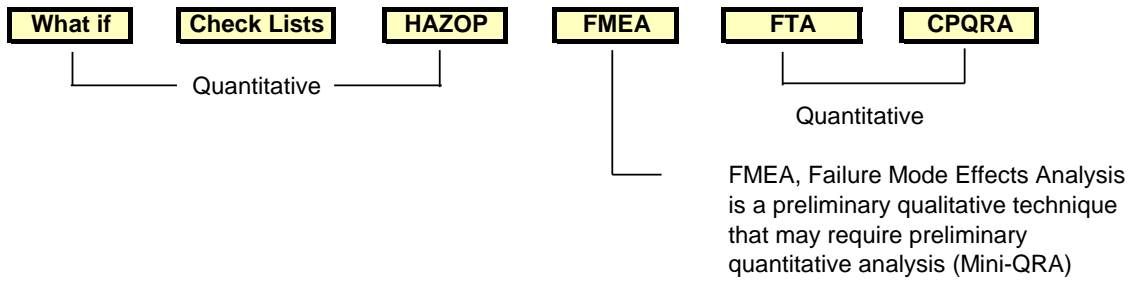


1 Hazard Evaluation, HE, Techniques

The following are types of **HE**, techniques:



2 HAZOP Hazards and Operability Analysis

HAZOP was developed by Lawley (1974) of ICI. Based on early account by Elliott & Owen (1968)

Hazop studies are carried out by an experienced, multidisciplinary team, who review all physical aspects of a process (lines, equipment, instrumentation) to discover potential hazards and operability problems using a check list approach.

The basis for a HAZOP is a critical examination of information found in a word model, a process flowsheet, a plant layout, equipment specification or a P&ID, (Piping and Instrument Drawing).

The principals of examination include:

- 1 Intention
- 2 Deviation
- 3 Causes
- 4 Consequences
 - (a) hazards
 - (b) operating difficulties
- 5 Safeguards
- 6 Recommendations / Actions

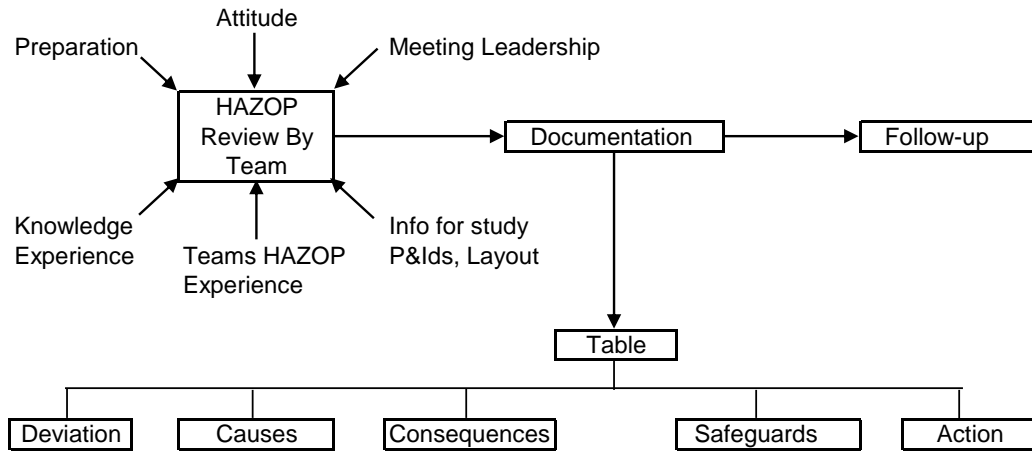
3 Early HAZOP studies used the following set of **Guide Words** to systematically review the process:

NO or NOT	Negation of intention	No Flow of A
MORE	Quantitative increase	Flow of A greater than design flow
LESS	Quantitative decrease	Flow of A less than design flow
AS WELL AS	Quantitative increase	Transfer of some component additional to A
PART OF	Quantitative decrease	Failure to transfer all components of A
REVERSE	Logical opposite of intention	Flow of A in direction opposite to design direction
OTHER THAN	Complete substitution	Transfer of some material other than A

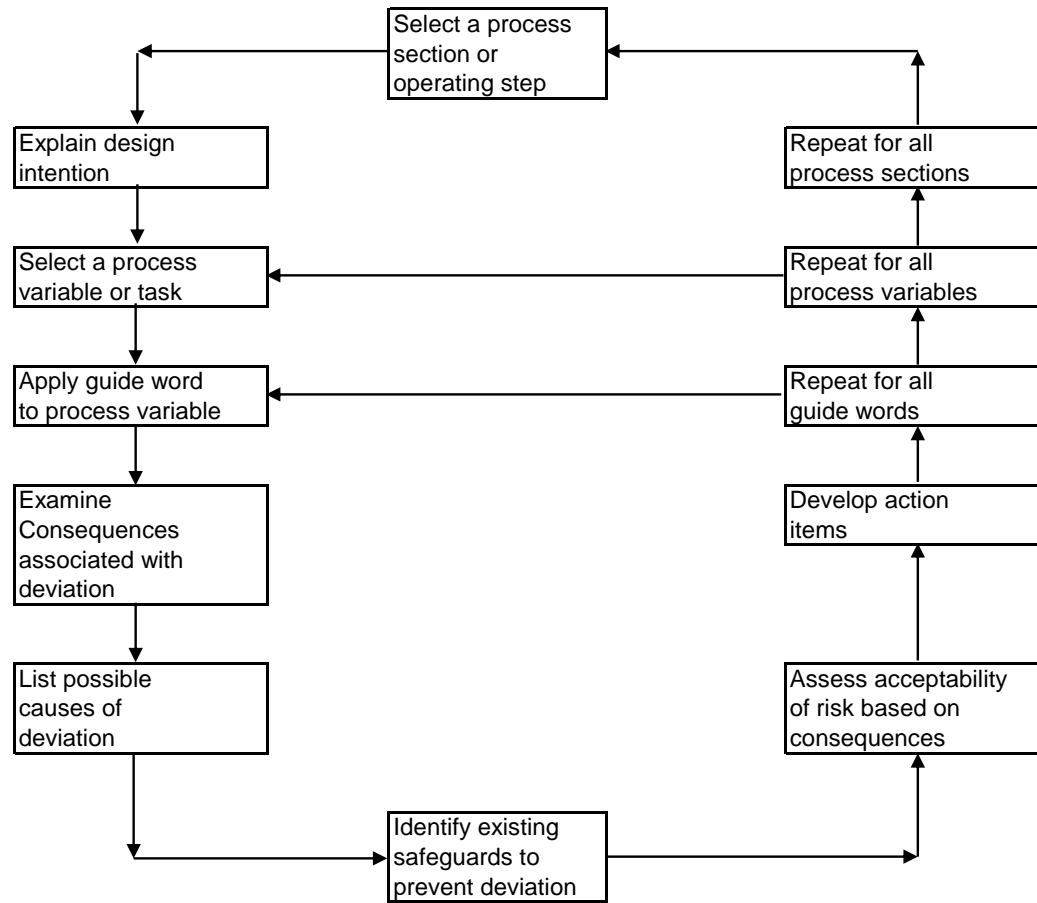
4 Some Common HAZOP Analysis Process Parameters

Flow	Time	Frequency	Mixing
Pressure	Composition	Viscosity	Addition
Temperature	pH	Voltage	Separation
Level	Speed	Toxicity	Reaction

5 **Prepare for the review**



6 HAZOP analysis method flow diagram



7 Potential HAZOP Pitfalls

1 Poor understanding by management of the HAZOP procedure

An Ethylene plant has 100 P&IDs, 625 equip't items.	625	items	a
Consider 5 variables, Pressure, Temperature, Flow Composition and Function.	5	variables	b
Consider 6 Guidewords, None, More of, Less of Part of, More than and Other than.	6	guide words	c
Questions to be answered =	18750	questions	d = axbxc
Consider 5 minutes per question =	5	min./question	e
Time for ethylene plant HAZOP study =	93750	minutes	f = dx e
4 hour, 240 minutes sessions per day =	250	minutes/day	g
No. working of days =	375	days	h = f / g
Days per week =	5	days/week	l
No. of weeks to complete HAZOP for plant =	75	weeks	j = h / l

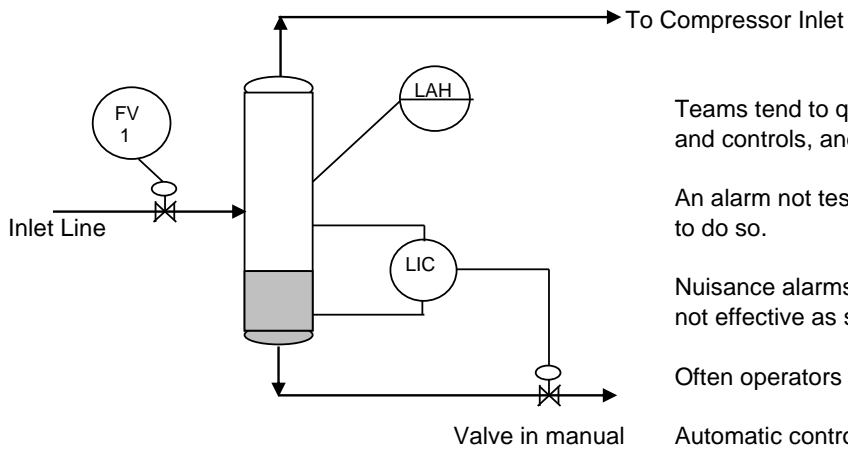
2 Inexperienced HAZOP team

3 Inadequately trained or in-experienced leader

8 **Common Mistakes**

- 1** Failing to establish a "safe" environment for team members
- 2** Consequences of events not carried to conclusion.
- 3** Taking unwarranted credit for safeguards
- 4** Too little credit given for safeguards
- 5** Making recommendations as specific as possible
- 6** Poor recording of HAZOPS
- 7** Failure to HAZOP start-up and shut-down procedures
- 8** Poorly up-dated P&IDs
- 9** A HAZOP is performed in lieu of properly executed design reviews
- 10** Wrong technique for system being reviewed (See spreadsheet titled Fig 5.3)

9 HAZOP Example



Teams tend to quickly identify alarms, shut-downs and controls, and claim them for safeguards.

An alarm not tested may not work when called upon to do so.

Nuisance alarms are frequently bypassed and are not effective as safeguards.

Often operators are not monitoring control panel.

Automatic control routines are often set in manual mode.