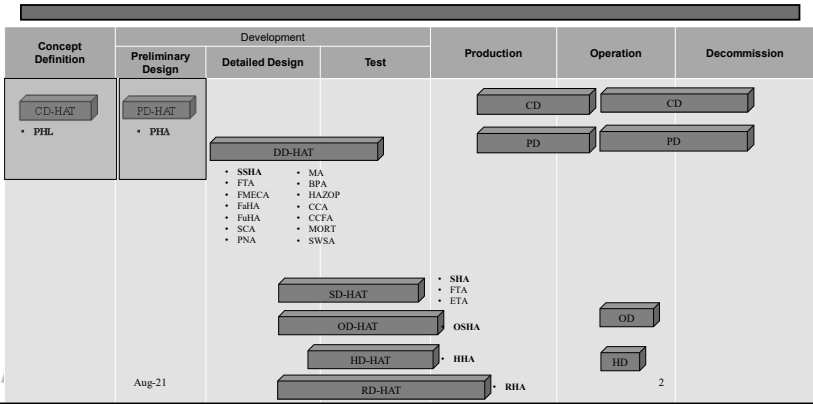


# Preliminary Hazard List (PHL) Preliminary Hazard Analysis (PHA)



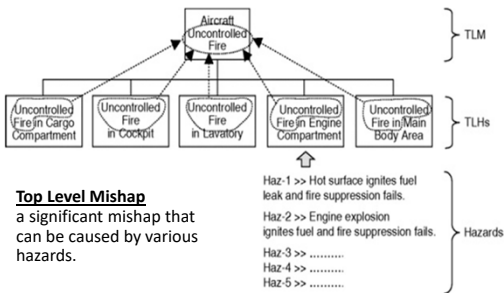
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## Life Cycle Phase



2

## Top Level Mishap (TLM)



Aug-21

3

## PHL vs PHA Purpose

### PHL

- Identify, list potential hazards
- Identify safety critical factors (SCF)
- Identify mishap categories
- Foundation for all other subsequent hazard analyses
- Affect the design for safety as early as possible

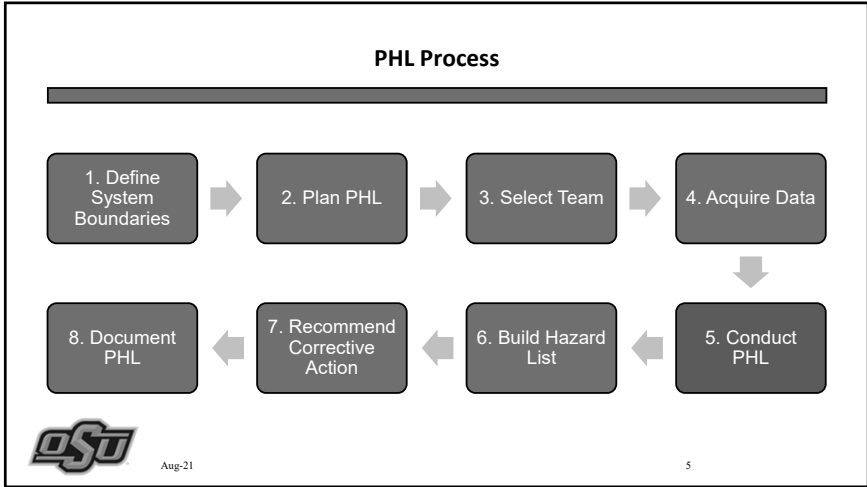
### PHA

- Analyze identified hazards, e.g., PHL
- Identify any previously unrecognized hazards
- Establish Safety System Requirements (SSRs) to mitigate hazards with unacceptable risk
- Identify hazard causal factors (HCFS), safety critical functions (SCFs) and Top Level Mishaps (TLMs)

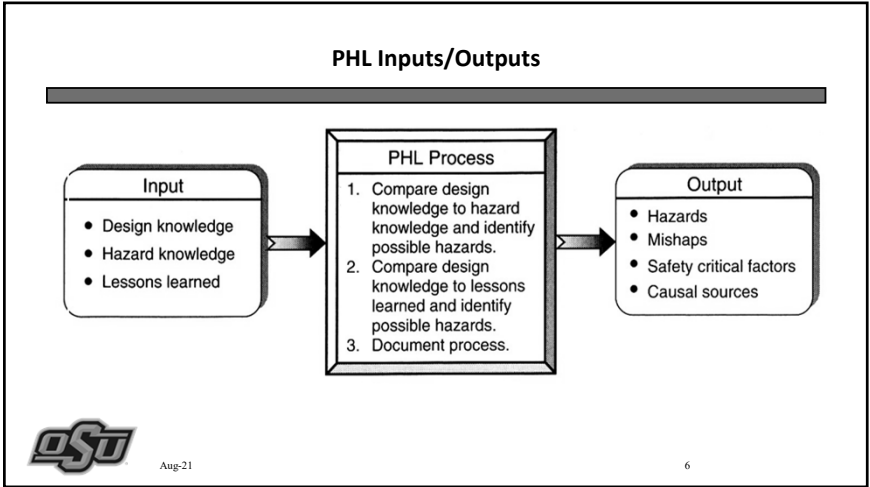


Aug-21

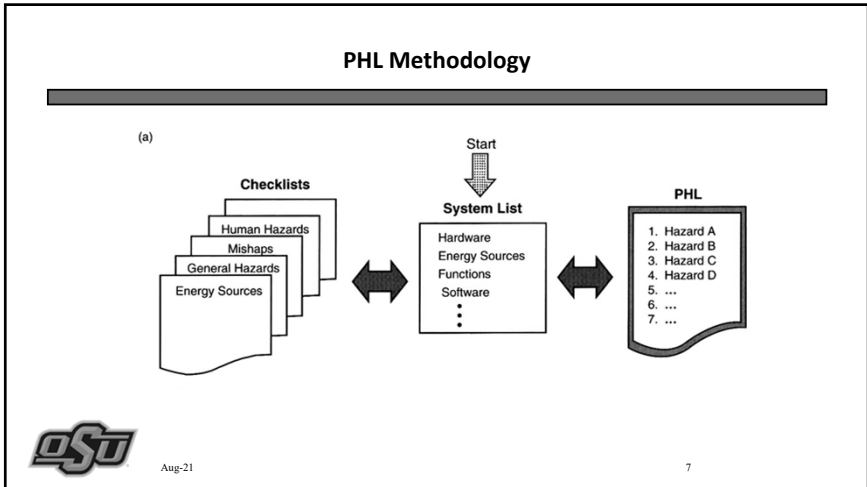
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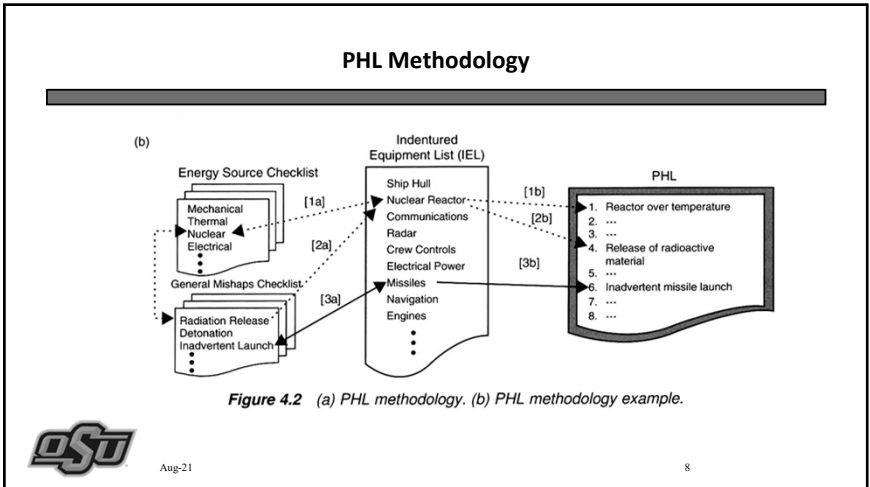
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8

PHL Worksheet

PRELIMINARY HAZARD LIST (PHL)

SYSTEM ELEMENT: 1

No.	Hazard Source Item	Hazard	Hazard Effects	Comments
2	3	4	5	6



Aug-21

9

PHL/PHA Checklists

(a)

Checklists

Human Hazards

Mishaps

General Hazards

Energy Sources

Start

System List

Hardware

Energy Sources

Functions

Software

...

PHL

1. Hazard A

2. Hazard B


3. Hazard C

4. Hazard D

5. ...

6. ...

7. ...



Aug-21

10

Energy Sources Checklist

1. Fuels

2. Propellants

3. Initiators

4. Explosive charges

5. Charged electrical capacitors

6. Storage batteries

7. Static electrical charges

8. Pressure containers

9. Spring-loaded devices

10. Suspension systems

11. Gas generators

12. Electrical generators

13. RF energy sources

14. Radioactive energy sources

15. Falling objects

16. Catapulted objects

17. Heating devices


18. Pumps, blowers, fans

19. Rotating machinery

20. Actuating devices

21. Nuclear

22. Cryogenics



Aug-21

11

General Sources Checklist

1. Acceleration

2. Contamination

3. Corrosion

4. Chemical dissociation

5. Electrical

Shock

Thermal

Inadvertent activation

Power source failure

6. Explosion

7. Fire

8. Heat and temperature

High temperature

Low temperature

Temperature variations

9. Leakage

10. Moisture

High humidity

Low humidity

11. Oxidation

12. Pressure

High

Low

Rapid change

13. Radiation

Thermal

Electromagnetic

Ionizing

Ultraviolet

14. Chemical replacement

15. Shock (mechanical)

16. Stress concentrations

17. Stress reversals


18. Structural damage or failure

19. Toxicity

20. Vibration and noise

21. Weather and environment

22. Gravity



Aug-21

12

General Operations Checklist

- 1. Welding
- 2. Cleaning
- 3. Extreme temperature operations
- 4. Extreme weight operations
- 5. Hoisting, handling, and assembly operations
- 6. Test chamber operations
- 7. Proof test of major components/subsystems/systems
- 8. Propellant loading/transfer/handling
- 9. High-energy pressurization/hydrostatic-pneumostatic testing
- 10. Nuclear component handling/checkout
- 11. Ordnance installation/checkout/test
- 12. Tank entry/confined space entry
- 13. Transport and handling of end item
- 14. Manned vehicle tests
- 15. Static firing



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13

13

Failure States Checklist

- 1. Fails to operate
- 2. Operates incorrectly/erroneously
- 3. Operates inadvertently
- 4. Operates at incorrect time (early, late)
- 5. Unable to stop operation
- 6. Receives erroneous data
- 7. Sends erroneous data

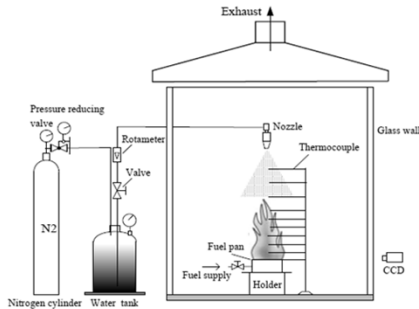


Aug-21

14

14

Example: Fire Suppression System



Aug-21

15

15

PRELIMINARY HAZARD LIST

SYSTEM ELEMENT: Pressurized Water Fire Suppression System				
No.	System Item	Hazard	Effects	Comments
PHL-1	Nitrogen cylinder			
PHL-2	Water tank			
PHL-3	Fuel Pan			
PHL-4	Thermocouple			


16

PRELIMINARY HAZARD LIST				
SYSTEM ELEMENT: Pressurized Water Fire Suppression System				
No.	System Item	Hazard	Effects	Comments
PHL-1	Nitrogen cylinder	Unintended release of stored pressure	Displacement of oxygen Projectiles of cylinder or shrapnel Loss of System Damage to surrounding area	SCF/TLM • Compressed Gas Cylinders pamphlet P-1) • 1910.253(b)
PHL-2	Water tank	Failed to operate as intended due to lack of supply	System will not extinguish fire as designed. Loss of system	SCF/TLM • ANSI/WSC PST 2000/2016
PHL-3	Fuel Pan	Leak Loss of containment	Fire spread outside of control area	SCF/TLM
PHL-4	Thermocouple	Malfunction	No/loss of data Innacurate Reading	

17

PHL Advantages

- Easy to perform as an initial hazard tool
- Quick, inexpensive
- Does not require great expertise
- Systematic framework for hazard identification
- Locates major system hazards and mishaps
- Effective means to gather information for PHA and future hazard analysis methods.


 Aug-21

18

18

Common Mistakes

- Not using a structured approach
- Not researching similar systems
- Not collecting and using common hazard source checklists
- Not listing ALL concerns or credible hazards


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19

19

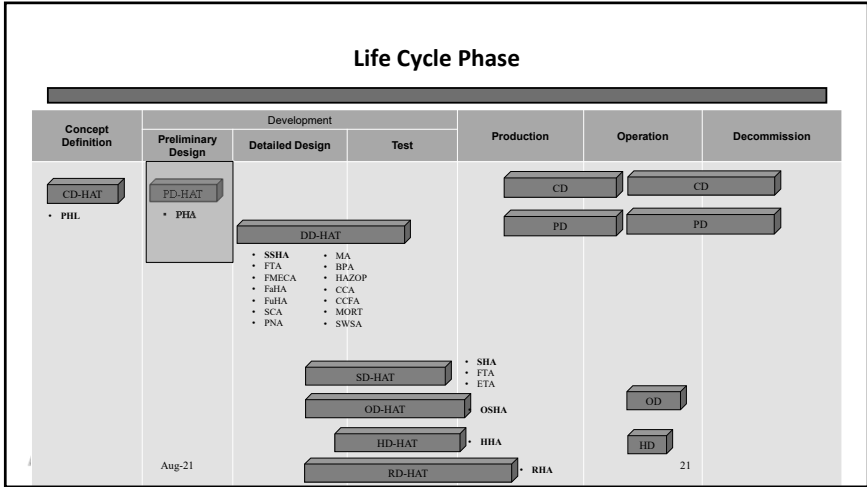
Common Mistakes

- Failure to document hazards found not to be credible (VERY IMPORTANT)
- Not establishing a correct list of hardware, functions and mission phases and indentured equipment
- Assuming the reader will understand the description from an abbreviated statement with project unique terms and acronyms.

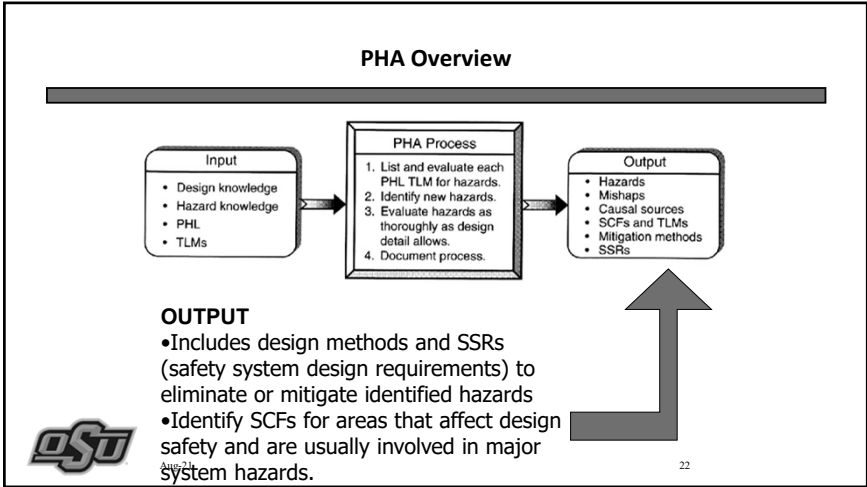
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20

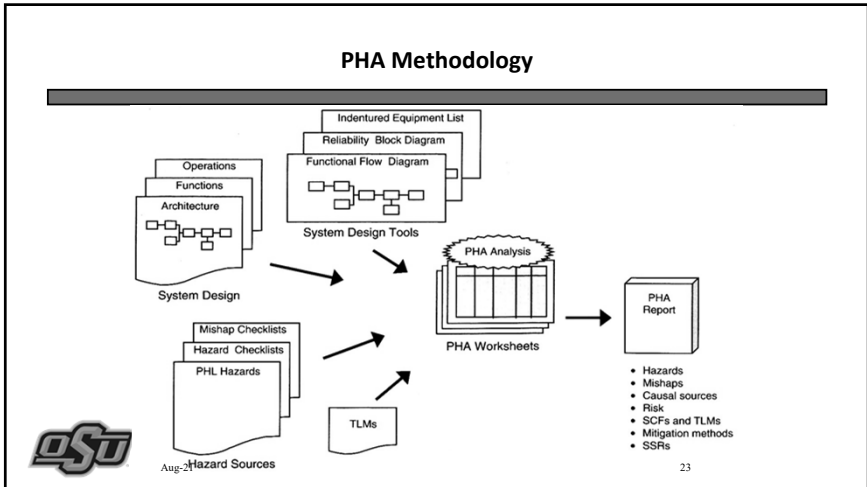
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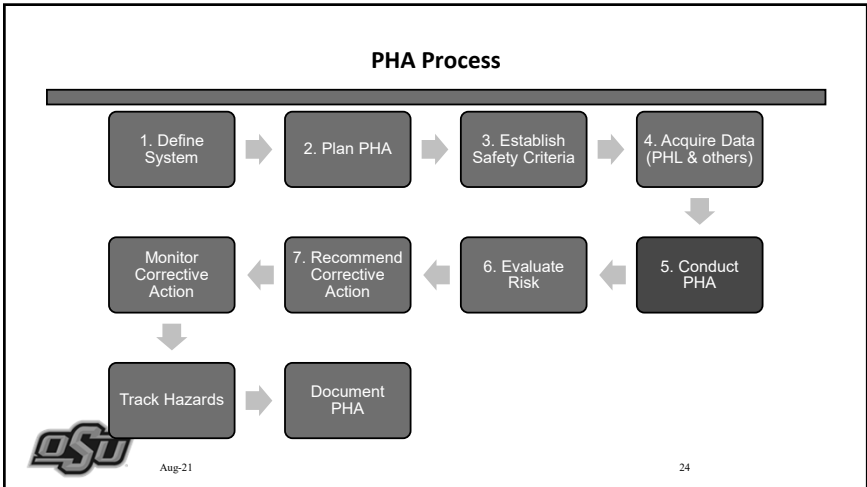
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23



24

PHA Worksheet

System: Subsystem/Function:		Preliminary Hazard Analysis						Analyst: Date:	
No.	Hazard	Causes	Effects	Mode	IMRI	Recommended Action	FMRI	Comments	Status
5	6	7	8	9	10	11	12	13	14

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25

25

Risk Assessment Matrix

Frequency of Occurrence		Hazard Categories			
		Catastrophic I	Critical II	Marginal III	Negligible IV
Frequent	A 1 in 10				
Probable	B 1 in 100				
Occasional	C 1 in 1000				
Remote	D 1 in 10,000				
Improbable	E 1 in 1,000,000				
Eliminated	F				

OSU

Aug-21

26

26

Corrective Actions

- Order of Precedence
- MILStd-882
- Eliminate or reduce hazards through design selection.
- Incorporate safety devices, systems, features.
- Provide warning devices.
- Develop procedures and training.

Higher vs. Lower Order Controls

Hierarchy of Controls

Elimination

Substitution

Engineering Controls

Administrative Controls

PPE

Physically remove the hazard

Replace the hazard

Isolate people from the hazard

Change the way people work

Protect the worker with Personal Protective Equipment

Higher order

Lower order

Best practice

Life Cycle Value

July 18, 2016

27

27

PHA Outputs

Input

PHA Process

Output

Design knowledge

Hazard knowledge

PHL

TLMs

1. List and evaluate each PHL TLM for hazards.

2. Identify new hazards.

3. Evaluate hazards as thoroughly as design detail allows.

4. Document process.

Hazards

Mishaps

Causal sources

SCFs and TLMs

Mitigation methods

SSRs

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28

28

Lecture Notes PHL & PHA

7

PHA Guidelines

- Products: hazards, effects, causal factors, risks.
- List, evaluate hardware subsystems (IEL), functions, energy sources on separate worksheets. For each category, identify hazards that may cause TLMs.
- PHL hazards must be converted to TLMs for the PHA.



Aug-21

29

PHA Guidelines

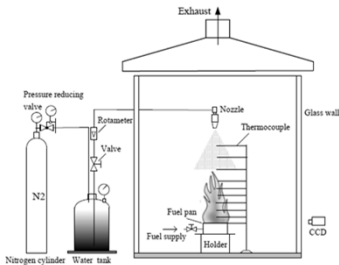
- For each hazard, identify and estimate causal factors and effects.
- Continue to establish TLMs and SCFs during PHA
- Review PHL to verify all hazards were covered in the TLM process.



Aug-21

30

Example: Fire Suppression System



Aug-21

31

PRELIMINARY HAZARD LIST

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No.	System Item	Hazard	Effects	Comments
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PHL-4	Thermocouple	Malfunction	No/loss of data Innacurate Reading	



Aug-21

31

32



PRELIMINARY HAZARD ANALYSIS							
Date	Hood Fire Protection System			Group			
No.	Hazard	Causes	Effects	IMRI	Recommendation	FMRI	Comments
PHA-1	Nitrogen Cylinder Rupture	Improper Storage Being Struck by another object (i.e. forklift or vehicle)	Loss of System Damage to surrounding areas from released of pressure	3C	Secure Cylinder with chains or place in impact resistant cage Prohibit powered industrial trucks from operating in area.	4E	Compressed Gas Cylinders pamphlet P-1) 29CFR1910.253(b)
PHA-2							
PHA-3							
PHA-4							

Aug-21

33

33

PRELIMINARY HAZARD ANALYSIS							
Date	Hood Fire Protection System			Group			
No.	Hazard	Causes	Effects	IMRI	Recommendation	FMRI	Comments
PHA-1	Nitrogen Cylinder Rupture	Improper Storage Being Struck by another object (i.e. forklift or vehicle)	Loss of System Damage to surrounding areas from released of pressure	3C	Secure Cylinder with chains or place in impact resistant cage Prohibit powered industrial trucks from operating in area.	4E	Compressed Gas Cylinders pamphlet P-1) 29CFR1910.253(b)
PHA-2	Water Tank	Valve malfunction Valve left closed Not enough water in tank Nozzle clogged/corroded	Failed to operate due to lack of supply System will not operate as intended	2C	Supervised (locked open) valve (SSR) Install a water level indicator (SSR) Install auto fill supply source (SSR)	2D	NFPA 13
PHA-3	Fuel Pan	Hole in the pan cause by corrosion or damage Overflow fuel Malfunction of fuel pan holder	Leak Loss of containment	2C	Provide Secondary Containment (SSR) Use corrosion resistant material (SSR) Implement PM program	2D	
PHA-4							

Aug-21

34

34

PHA Advantages

- Relatively easy and quick to perform (from PHL and early design information)
- Relatively inexpensive but meaningful: cost-effective
- Systematic approach for identification and evaluation of all hazards at this design level
- Initial risk estimations for majority of system hazards.
- Commercial software available to facilitate PHA



Aug-21

35

35

PHA – Limitations

- PHA does not assess risks of combined system hazards.
- False conclusions could result



Aug-21

36

36