The Global Explosion-Protected Equipment Market - Can US Coal Mines Ever Benefit?

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Background

NIOSH initial interest - immediately after MINER Act:

- Equipment approvals were taking more than a year.
- IS communications equipment available; not MSHA-approved.
- Asst. Sec. of Labor for MSHA expressed interest in international standards
  - Requested NIOSH assistance in resolving the “level of protection” requirement
  - Left role in 2009

NIOSH technology implementation role under the Act and stakeholder input drove continued interest.

- Evolution and size of global explosion protection market implies ability to use IEC standards will improve equipment availability and help innovation.
  - Tens of thousands (OSHA NRTLs) vs a few hundred (MSHA)
- 13 explosion protection techniques/standards under IEC
  - only 2 are comparable to Permissibility requirements
    - 2-fault Intrinsic Safety
    - XP enclosures

Explosion protection techniques and protection levels

Protection Level	IEC/ISA and US NEC 505 Technique	MSHA Similar Technique
Zone 0 Applications continuous explosive atmosphere	Intrinsic Safety (IS) - 2 Fault ⟷	IS – 2 Fault
	Encapsulation (Ma)	None (except as part of IS)
Zone 1 Applications frequently explosive atmosphere	Intrinsic Safety (IS) - 1 Fault	None
	Flameproof (FP) Enclosure ⟷	Explosion-Proof (XP) Enclosure
	Powder Fill	None
	Pressurization	None
	Increased Safety	None
	Oil Immersion	None
	Encapsulation (Mb)	None
Zone 2 Applications infrequently explosive atmosphere	Non-sparking	None
	Non-incendive (aka IS for zone 2)	None
	Enclosed Break	None
	Restricted Breathing	None

History of explosion protection techniques

- 1913 explosion at a colliery in Wales, which killed 439 miners and a rescuer, led to development of the Intrinsic Safety (IS) approach.
- USBM developed the first containment approach in 1915 (XP enclosures and motors).
- Explosion protection market expanded to other industries as the use of plastics and petroleum products proliferated.
- By the 1960's new techniques were being developed to support new technologies and needs.
- Today these techniques are well documented in a series of IEC standards (IEC 60079 standards).
  - Country specific versions used throughout the world.
- OSHA is required to use consensus standards.
- Our primary interest has been Intrinsic Safety standards.

Project summary timeline

Meet with Assistant Secretary Stickler – February 2008

Begin Comparison of 2-fault IS standards/criteria – 2011

- Review team included MSHA A&CC, UL, FM, and NIOSH PMRD SMEs

First Draft of 2-fault IS Comparison Report – July 2013

- SME's unable to determine safety implications of specific provisions

Engagement of William Calder – June 2013

- 40 year history of the standards
- engaged to make the equivalency determination in cooperation with A&CC

Publication of 2-fault IS comparison report – November, 2016

2-fault IS equivalency finding for portable equipment– February 2017

Extension of 2-fault IS findings to all equipment – October 2017

2-fault intrinsic safety

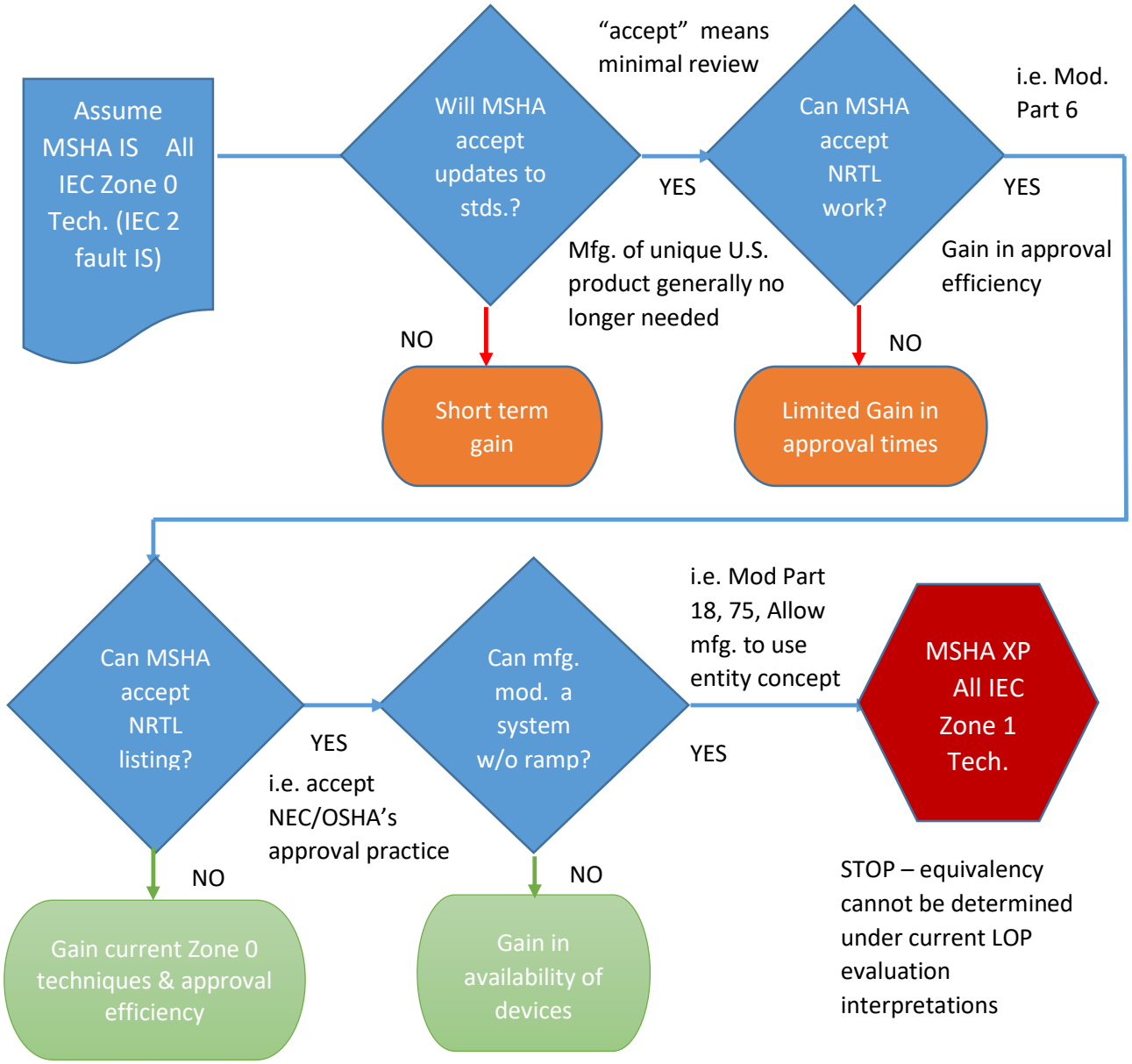
Standard was determined to provide an Equipment Protection Level (EPL) equivalent to the current MSHA criteria.

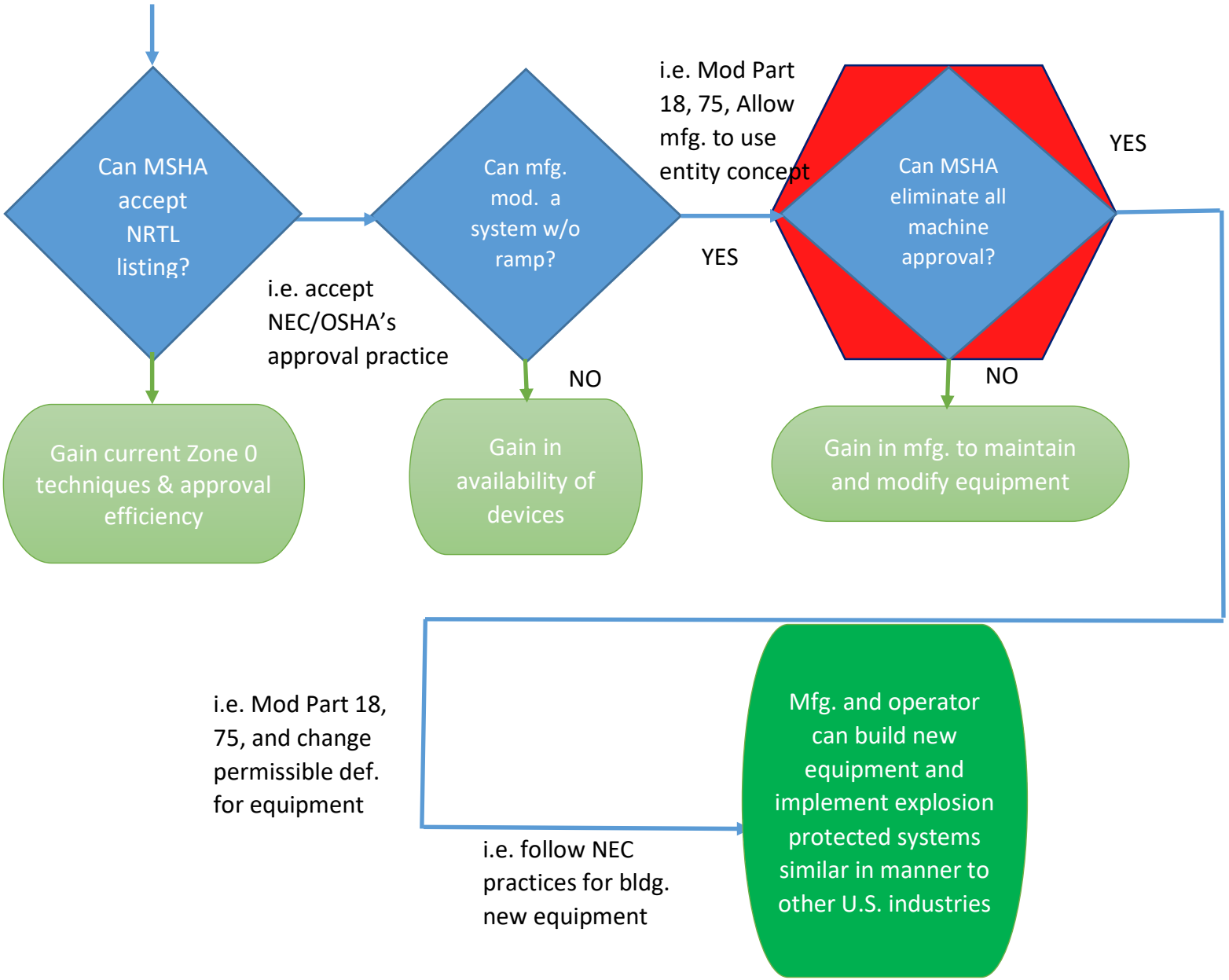
- Determination made by line by line comparison of the two documents and other methods
- Key safety aspects - IEC slightly more conservative than MSHA

Falls within the zone 0 EPL internationally.

- By extension one could argue that MSHA could consider acceptance of other zone 0 techniques as they are developed
  - Encapsulation Ma is only other current technique in zone 0 EPL grouping
  - In the future, zone 0 techniques may include combinations of zone 1 and 2 techniques

SO NOW WHAT? What policy changes would be necessary to “implement” IEC standards in the U.S. coal industry?


Assume MSHA IS All IEC Zone 0 Tech. (IEC 2 fault IS)
Will MSHA accept updates to stds.?
"accept" means minimal review
YES
Can MSHA accept NRTL work?
i.e. Mod. Part 6
YES
Gain in approval efficiency
Mfg. of unique U.S. product generally no longer needed
NO
Short term gain
NO
Limited Gain in approval times
Can MSHA accept NRTL listing?
YES
i.e. accept NEC/OSHA's approval practice
Can mfg. mod. a system w/o ramp?
i.e. Mod Part 18, 75, Allow mfg. to use entity concept
YES
MSHA XP All IEC Zone 1 Tech.
NO
Gain current Zone 0 techniques & approval efficiency
NO
Gain in availability of devices
STOP – equivalency cannot be determined under current LOP evaluation interpretations


Can MSHA accept NRTL listing?
Gain current Zone 0 techniques & approval efficiency
i.e. accept NEC/OSHA's approval practice
Can mfg. mod. a system w/o ramp?
NO
Gain in availability of devices
i.e. Mod Part 18, 75, Allow mfg. to use entity concept
YES
Can MSHA eliminate all machine approval?
NO
Gain in mfg. to maintain and modify equipment
YES
i.e. Mod Part 18, 75, and change permissible def. for equipment
i.e. follow NEC practices for bldg. new equipment
Mfg. and operator can build new equipment and implement explosion protected systems similar in manner to other U.S. industries

Suitable areas (zones) for explosion protection techniques within a mine or facility

IEC Zone Grouping	IEC/ISA and US NEC 505 Technique		MSHA Similar Technique
Zone 0 Applications	Intrinsic Safety (IS) - 2 fault	⟷	IS – 2 fault
	Encapsulation (Ma)		None (except as part of IS)
Zone 1 Applications	Intrinsic Safety (IS) - 1 fault		
	Flameproof (FP) enclosure	⟷	Explosion-proof (XP) enclosure
	Powder Fill		None
	Pressurization		None
	Increased Safety		None
	Oil Immersion		None
	Encapsulation (Mb)		None
Zone 2 Applications	Non-sparking		None
	Non-incendive (aka IS for zone 2)		None
	Enclosed Break		None

Note: Under Article 500 of the NEC there are only two groupings Division 1 and 2, Division 1 is presumed to include zone 0 and 1. $_{XP}$ enclosures are included in Division 1 under that Article, but such enclosures are not acceptable for zone 0 under IEC system.

Conclusions and Recommendations

IEC standards and MSHA criteria for 2-fault Intrinsic Safety provide an equivalent level of protection and our recommendation is that MSHA accept the US adopted version of the IEC standard as an alternative to the MSHA criteria.

- Technology findings are transferred to MSHA per September and prior meetings, moves to the policy realm.
- Acceptance of other standards require regulatory changes or level of protection determinations that are beyond the scope of this work.
- To the extent practical we have met intent of the Assistant Secretary's request.

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Answer to the title question?

For 2-fault intrinsically safe equipment and systems:

- We are hopeful that the U.S. mining industry can use equipment designed and built to IEC standards without modification.
  - This is the currently the most important equipment category.
  - Technique applies to man wearable equipment, sensors, and processors needed for future safety and health improvements through automation.
  - Price of these devices are highly volume sensitive and the technologies are changing rapidly.

For using flameproof containers designed to IEC standards as an alternative to MSHA approved XP containers:

- The issues associated with the use of such containers would be very difficult to resolve and there is not an obvious compelling need for it.

For the other explosion protection techniques:

- It may be possible for Encapsulation Ma to be adopted since it falls into the same EPL as 2-fault intrinsic safety.
- Adoption of the other techniques would require substantial changes for which there is not a current compelling need.

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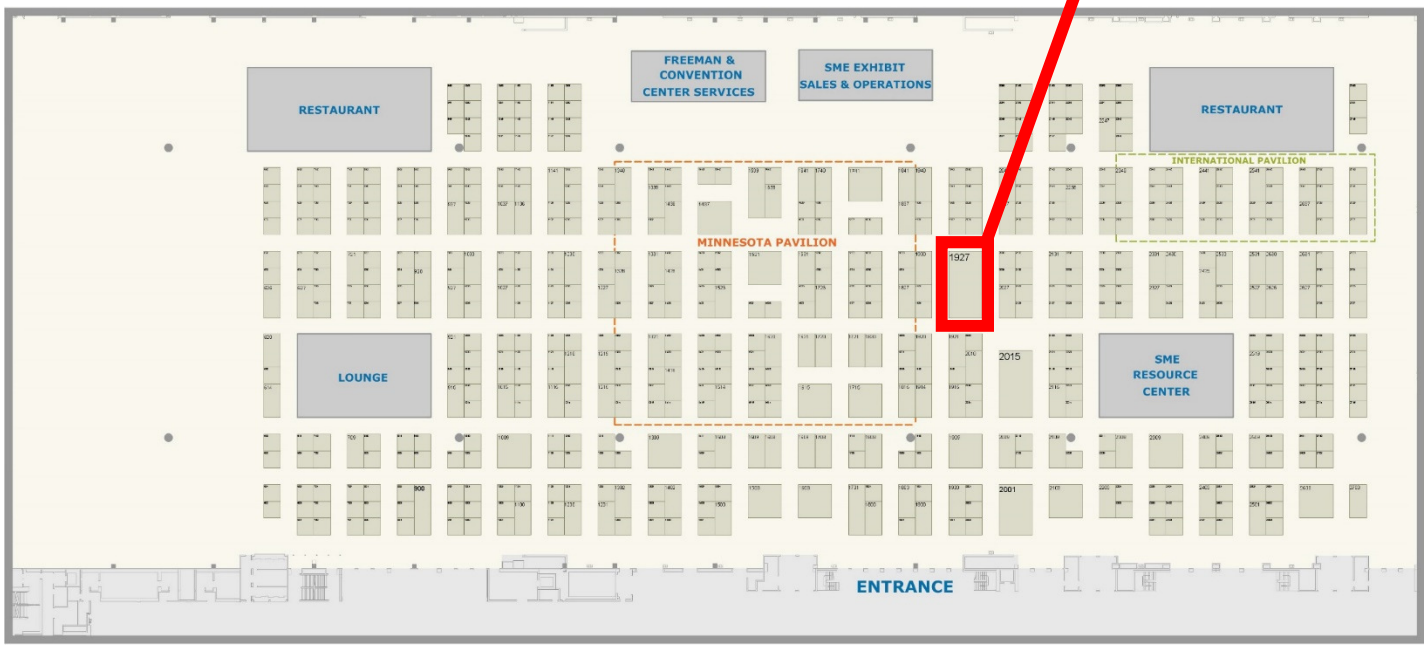

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