

**APPS 2018**  
ASIA PACIFIC PERFORATING SYMPOSIUM

# Recovery of Perforating Guns where the Explosives are Thermally Overexposed

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INTERNATIONAL PERFORATING FORUM



**APPS-17-18**

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Hunting Energy Services

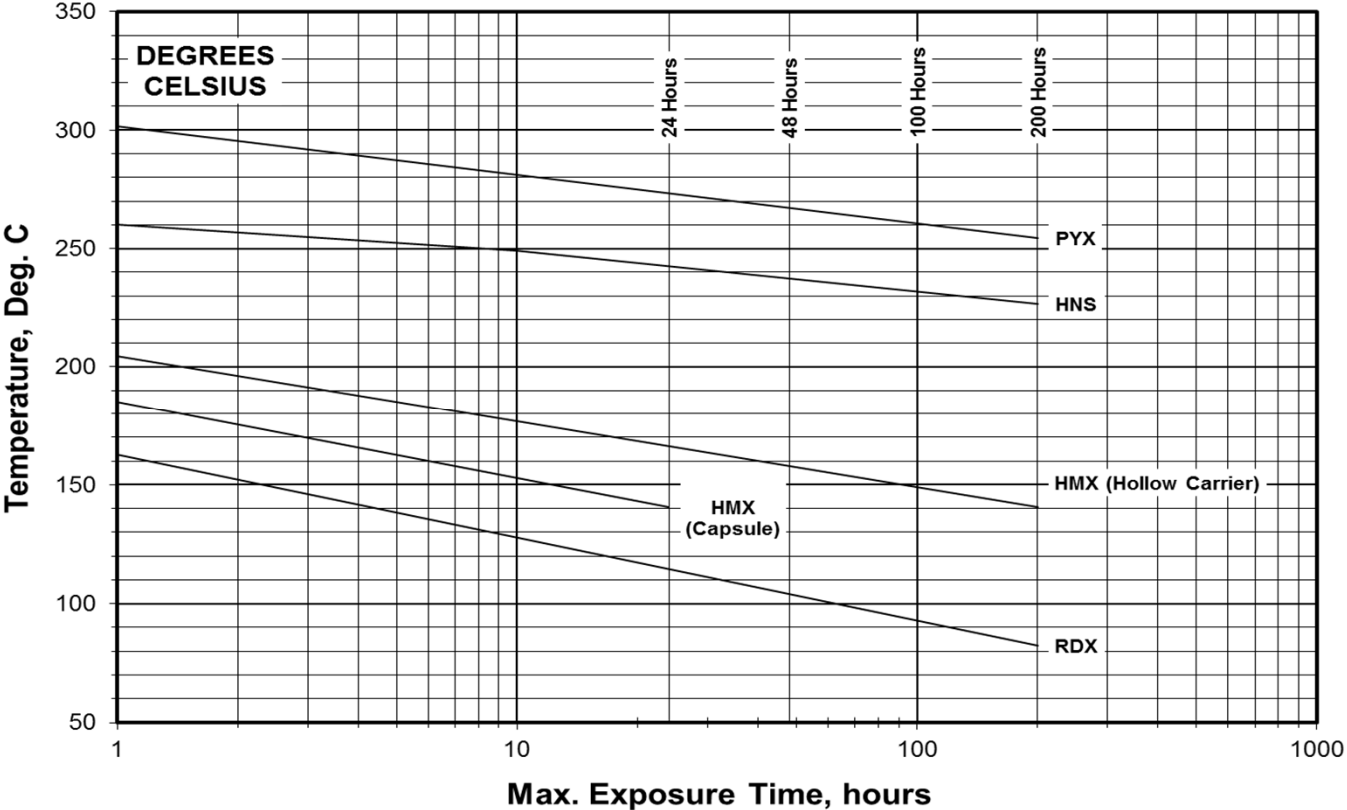
# AGENDA

- Basic Definitions
- Time versus Temperature with Explosives
- Issues regarding Thermally Overexposed Explosives
- Generic Procedure
- Conclusion

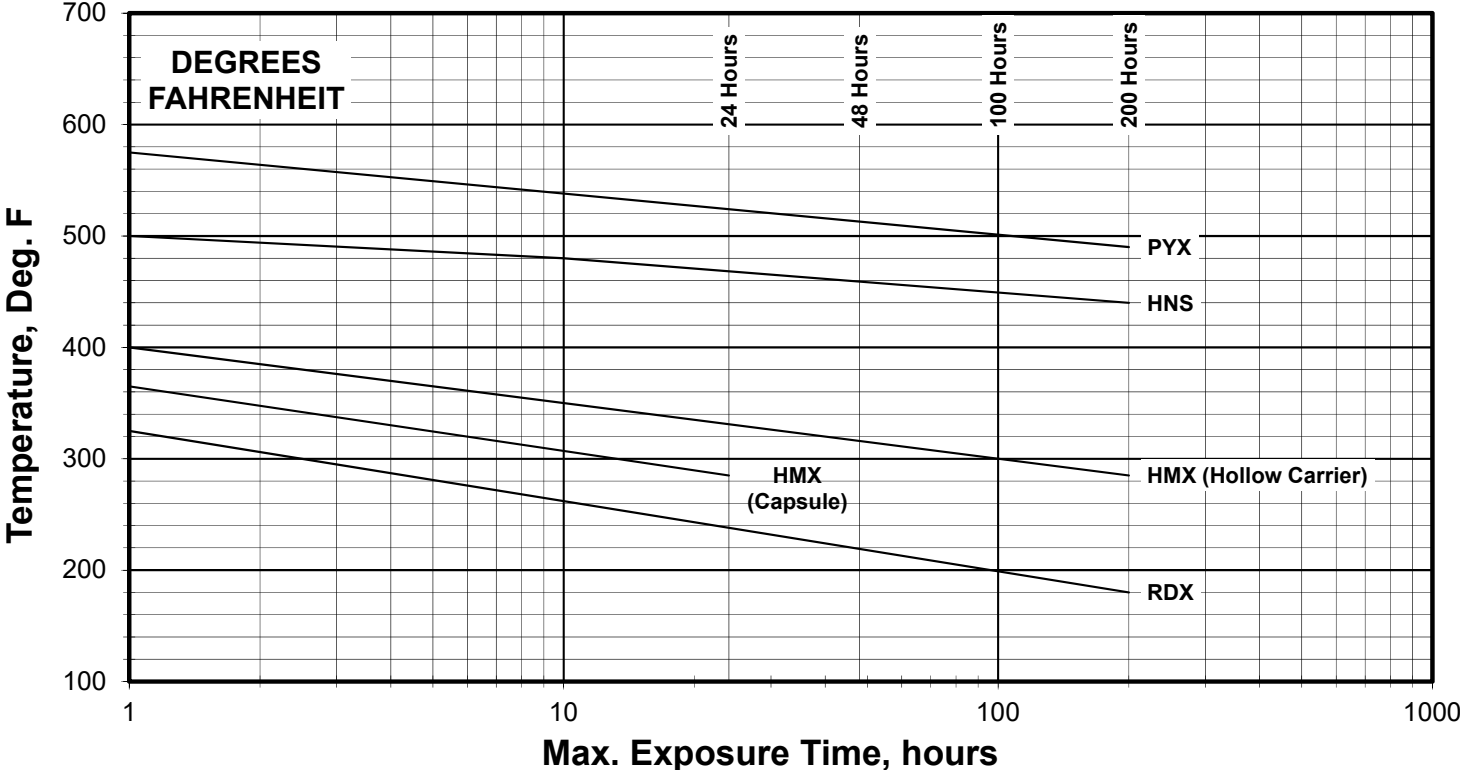
# Definitions

- High-Order Detonation “Detonate”
  - Chemical reaction that exceeds the speed of sound
  - RDX detonation velocity ~ 22,000 – 26,000 fps (6700 – 7900 mps)
  - HMX detonation velocity ~ 26,000 – 30,000 fps (7900 – 9100 mps)
- Low-Order Deflagration “Deflagrate”
  - Many times we refer to this as a “low-order burn”
  - Much less than the detonation velocity
- API RP-67 is a “Recommended Practice” and not a “Required Practice”
  - Each company may have their own interpretation of procedures

# Time versus Temperature – Deg C

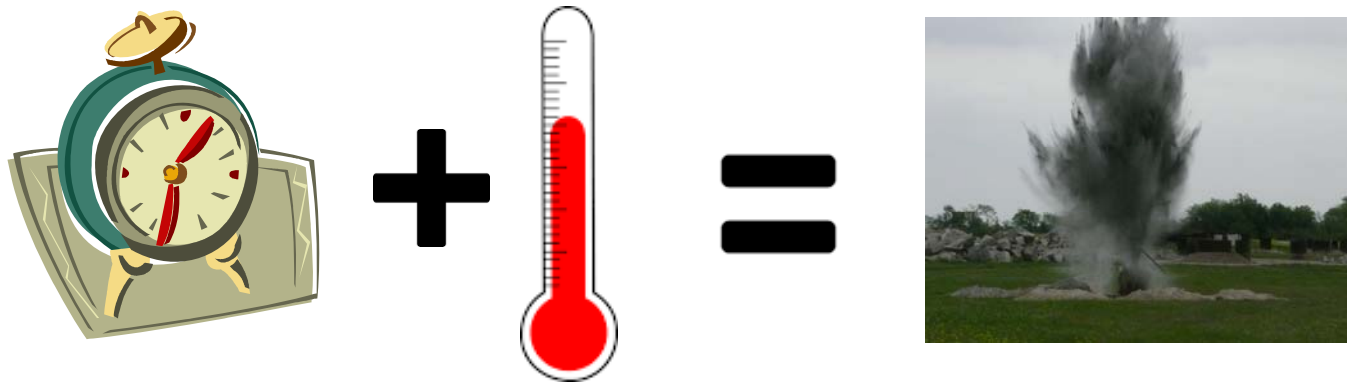


# Time versus Temperature – Deg F

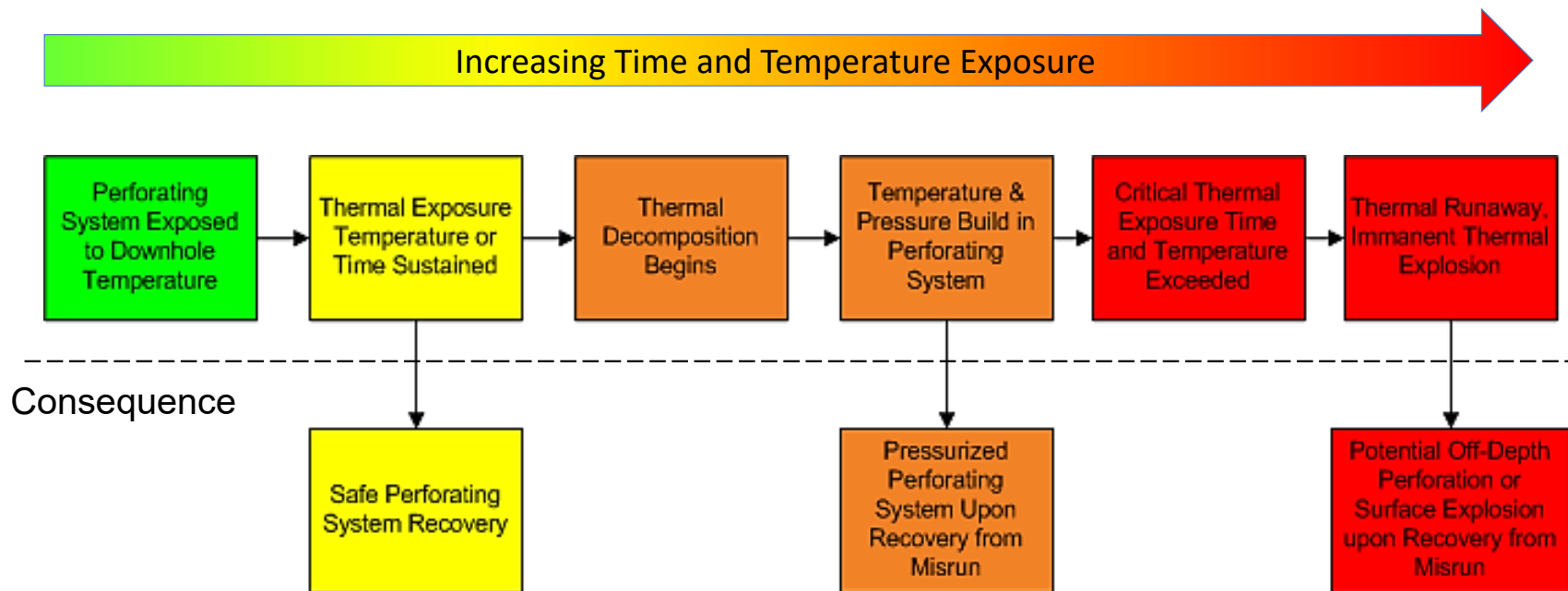


# Time versus Temperature Concerns

- No Safety Factors involved
- The clock starts once the perforating guns drop below the rig floor
- Interpretation of this chart is Customer Specific



# Increasing Time and Temperature



# API RP-67 – 3<sup>rd</sup> Edition

- Recently turned in to the API by the Steering Committee
  - Under review by the API
- There will be a section for Thermally Overexposed Explosive Devices



# Well Situation

- Scenario: You believe that the perforating guns did not detonate, OR you did not attempt to detonate the guns
  - OR The well is not flowing after attempted detonation
  - OR The well is not showing any sign of perforations
  - OR You pumped the perforating guns off of the line and fishing operations have exceeded time versus temperature for the explosives
  - OR The operation was delayed due to surface conditions, or well conditions, or weather, or catastrophic rig event
- AND You believe the explosives were thermally overexposed
- AND You believe you will pulling out LIVE perforating guns that are Thermally Overexposed
- Here is a “RECOMMENDED” guideline you can choose to follow:

# Generic Procedure Guidelines

- Step 1
  - Have a meeting between the Service Company and the Operator
    - Discuss all of the possible scenarios that were taken to determine what occurred downhole
    - Determine the time these explosives have been exposed to the BHT
    - Make sure the BHT is correct from logs, OR temp gradients, OR previous runs, OR from other wells in this area
      - Discuss differences between OH and CH BHT
    - Discuss ALL of the explosives that are in the perforating gun system
      - Detonator or Initiator
      - Detonating Cord
      - Shaped Charges
      - Boosters
    - Determine the lowest temperature rating of all explosive devices that are in the assembly

# Generic Procedure Guidelines

- Step 1 (cont)
  - When in doubt about the ratings of devices - refer to the MSDS sheets
  - Refer to specific company recommendations and procedures
  - If there are NO specific company recommendations
    - Refer to RP-67 to use as a guideline
  - Design a recovery plan that ALL parties agree upon to retrieve the live perforating guns
  - Determine what items will be necessary at the surface in order to properly handle the perforating guns
  - Items to consider:
    - Piercing Tool for pressure relief?
    - IR Thermometer for accurate temperature readings?
    - Water hose or availability of water?
    - Number of people exposed to the perforating guns?

# IR Temperature Thermometer

- The RayTemp 28 is a professional infrared, non-contact thermometer with dual laser dot alignment. The thermometer incorporates a 30:1 optic ratio (target distance/diameter ratio), which enables users to measure small targets from a distance or any item that is difficult to reach.
- 60:1 distance to spot ratio with dual laser sighting for fast, accurate targeting



# Water Hose and/or Sprayer

- Spray onto perforating gun to see if steam is generated
- Toss on to perforating gun to see if steam is generated



# Perforating Gun Punch

- Remotely punch a hole in a perforating gun to relieve internal pressure
- Limited on OD of perforating guns

Photo: Innovative Completion System



Recovery of Perforating Guns where the Explosives are Thermally Overexposed

# Generic Procedure Guidelines

- Step 1 (cont)
  - Items to Consider at this point
    - How long do you want to let the guns cool off before you reach surface?
      - Possible solution is to find a zone up the well to place the guns to COOL OFF
        - IF the guns were to detonate during this process – this zone would work
      - Determine the time to stay at that zone based on temperature at that depth
      - Recommend at least 30 minutes at this depth – extended time is always on your side
      - Bottom Line – You DO NOT want to handle ANY Explosive at the surface that could be in their thermally “excited” state!

# Generic Procedure Guidelines

- Step 2
  - Decisions were made in Step 1 to begin pulling out of the well
  - Conduct a Safety Meeting between ALL parties on location
  - Review Safety Procedures and Policies
  - Outline specific instructions for all personnel when the perforating guns reach the surface
    - What to do if the guns did fire
    - What to do if the guns did not fire
    - Necessary personnel on the rig floor
    - Safe Distances for personnel from the rig floor
    - Standby personnel in the event of an emergency



# Generic Procedure Guidelines

- Step 3
  - Begin Pulling out of the well with the perforating equipment
  - Do not get in a hurry and “assume” that the perforating guns are live and did not detonate
  - Continue to monitor the well for any possible sign of detonation
  - Pull up to the agreed location in the well for the perforating guns to “cool down” for an pre-agreed amount of time
  - At this point it would not hurt to conduct another safety meeting:
    - Key personnel
    - Safe Areas
    - Proper handling equipment
    - Emergency procedures
  - Once the agreed time is reached – continue to slowly pull the equipment out of the well

# Generic Procedure Guidelines

- Step 4
  - Bring the perforating gun assembly out of the well and make a visual inspection
    - Check to see if the perforating guns have detonated
    - If the perforating guns low-ordered AND there are visual signs of high pressures escaping or splits in the perforating guns – Carefully inspect all of the perforating guns (if applicable)
    - If it appears the perforating guns did NOT detonate
      - Record the time and take an external temperature measurement at a key location of the perforating gun
        - Bottom of gun, middle of gun, top of gun
      - If an IR Temperature Thermometer is not available then splash water, or spray water on the perforating gun to see if emits steam or shows the surface of the perforating gun to be hot
      - Keep the perforating guns stable and do not handle in the event the explosives are Live and in their excited state

# Generic Procedure Guidelines

- Step 4 (cont)
  - If the temperature is above 212°F (100°C)
    - Clear the area and wait a couple of hours
    - At this point you should notify management of the situation
    - Continue to take temperature readings every 2 hours until the temperature begins to decline
    - Note: Be sure to take the temperature readings in the same spot on the perforating guns
  - If the temperature is less than 212°F (100°C)
    - Wait approximately 15 minutes and take another temperature reading to ensure the temperature is decreasing
  - At this point - You want the temperature to decrease to a Safe Handling Temperature
  - Once the Safe Handling Temperature is achieved - proceed with reverse EBBA and disassembly
  - Always Be Aware Of Trapped Internal Pressure!

# Conclusions

- Thermally Overexposed Explosives are very dangerous to handle at the surface
- API Recommended Practices are just that – **Recommended**
  - Each company should have their own policies and procedures when dealing with Thermally Overexposed Explosives
- Use the Time / Temperature chart to determine if the explosives have exceeded their time at temperature
- Know the temperature ratings of ALL products (especially the explosives), along with the hardware prior to going in the well with the perforating gun assembly
- Never take short-cuts when dealing with explosives
- Better a thousand times careful than once dead - *proverb*

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**QUESTIONS?  
THANK YOU!**

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