IAFPA / ARFFWG
Joint Conference 2009
“Tools in the Toolbox “

Copenhagen Airport, Denmark
Tactical Considerations in ARFF: The “Smart Approach”
Smart Approach

- Don’t let tradition impede progress
- Learn from cumulative experience
- Look beyond the face value of technology
- Develop CRM model that facilitates success in emergency management
- Keep all plans and programs in DRAFT format
Targets of Study

- Airfield Response Plans
- Advanced Technology Integration and ARFF
- Historical Aviation Accident Review & Lessons Learned
Integrating Safety Management Systems (SMS) into Emergency Planning.
Integrating Safety Management Systems (SMS) into Emergency Planning

DEFINITIONS

- SMS: (ICAO) “the state in which the risk of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management.”

- SMS: (FAA) “the formal, top-down business-like approach to managing safety risk.”
Fire Service >>>>>>>Safety

- Fire Ground Safety
- Fire - Safety Inspections
- Safety Tips / Reminders
- Ramp Safety
- Accident Prevention
- Fire Prevention
Safety Culture

- ARFF should take a pro-active role in community safety services.
  - Airport working community
  - Airport transient community
  - Flying public

- Benefits
  - Community (s)
  - Relationship building

  **Emergency Management**
Community Resource Management (CRM)

- Hybrid of Cockpit/Crew Resource Management concept developed from NASA research
  - Main problems in majority aviation accidents caused by human factors were failures of interpersonal relationships, leadership and decision making in cockpit

- Definition expanded by Fire Service, now by ARFF

- ARFF serves as the nucleus, drawing community together to foster Safety Culture and plan for Emergency Event
ARFF Based Safety Culture

- Logical role for ARFF – Problem Solvers
- No competition in Safety
- Natural attraction to Fire Service
  - Culture, equipment, brotherhood
- Benefits
  - Safer Workplace
  - Relationships, cooperation, information exchange, reduced injuries, accidents, $$$
- Improved Emergency Management
  - Smart???
ARFF Airfield Response Plans
Problem: Airfield Response Planning Has Become More Difficult

- In late 1990’s inordinate number of Runway Incursions

- FAA’s drawn conclusions to the causes:
  - ATC errors
  - Pilot errors
  - Vehicle Drivers and Pedestrians
    - FAA released study and recommendations in Certalert #07-10 Vehicle Pedestrian Deviation (VPD) Runway Incursions

- Overall result is added complexity to planning and training for emergency response
Runway Incursions

- Runway Incursion has been on NTSB’s Most Wanted List Since 1990
- Sixteen (16) ARFF related runway incursions from January 2006 through April 2007 (FAA Certalert #07-10 Study)
- ICAO and FAA now share definition of Incursion due to seriousness of issue globally
- ARFF Vehicle Access has been reduced, yet Familiarity with Runway Needs to be Maintained
Solution: Low Risk Airfield Training

- Conduct off peak runway familiarization
- Perform tabletop drills and exercises:
  - *Street Drills*: Common practice in structural fire stations
    - Sit around table and talk through scenarios / response routes, conditions, traffic, etc.
  - *Airfield Communications Exercise*: Partner with ATC personnel and conduct communication exercise for simulated event
Solution: Develop New Airfield Response Model

- Informal study conducted to determine current methods of airfield response

- Typically traditional response model followed, which has been standard for 30 years, is less than ideal

- New airfield response model should be developed with goals to:
  - Reduce delays and risks
  - Better accommodate response, size up, set up and implementation of Incident Action Plans (IAPs)
Traditional Response Model Logic

Goals

- Reduce delays in response to landing runway by pre-positioning response assets
- Provide forward position in optimum viewing location to observe approach and landing
- Provide position of immediate access to runway for pursuit of aircraft as soon as it passed ARFF vehicle’s standby position
- Separate response assets out along landing runway to provide nearly immediate access by one ARFF vehicle at any point at which aircraft comes to stop
- Provide distance between ARFF vehicles so that if aircraft leaves runway during landing, number of ARFF vehicles in harm’s way minimized
Traditional Response Model

Issues

- If we follow aircraft down landing runway, we are approaching from downwind; we have learned that we want to be upwind from a fire

- Approaching aircraft from behind traveling on landing runway would require us to pass through debris field

- Approaching from the rear of aircraft may require vehicle to drive around aircraft
  - Potential J-Turn
  - Escape slides may be deployed
  - Driving off-road may be risky maneuver
    - Risk Analysis
New Response Model Goals

- Reduce delays and risks
  - Use of a Discrete Emergency Frequency (DEF)
  - Avoidance of primary taxiways favored by the Tower to taxi aircraft

- Better accommodate response, size up, and set up

- Improve Incident Action Plans (IAPs)

- Avoid high risk airfield locations
Highest Risk Airfield Locations

- Avoid “hot spots” identified by the airport, particularly in designating standby positions
- Avoid areas of radio interference or dead spots
- Avoid areas that may be impacted by known or suspected aircraft problem
- Identify areas of airfield most likely to become actual site of an aircraft incident
Runway Approaches and Departures are High Risk Areas to Occupy

- ACRP Risk Assessment “Analysis of Aircraft Overruns and Undershoots for Runway Safety Areas” (2008) provides modeling data and formulas to analyze runway safety areas for airfield response planning and improvement of areas.

- Airline Pilots Association Report (1997) reported consistent overall pattern as illustrated in graph.
Conclusions: “Smart” Airfield Response Planning

- Re-evaluate existing Airfield response routes, procedures and standby positions
  - Utilize airfield characteristics and risk analysis
    - Response routes may not be shortest distance
    - Consider “hot spots” and dead spots
    - Avoid, when possible, following aircraft down runway

- Harmonize with department tactical plans
Advanced Technology Integration Is Part of Our “Smart Approach”

- We have the ability to move the advanced technology market forward
  - Participation in Working Groups and Committees to affect minimum standards

- Advanced Technology allows us to:
  - Increase vehicle stability and safety
  - Respond faster and more effectively in low / no visibility conditions
  - Knock down an aircraft fire faster
  - Be better prepared and trained for emergency response
Problem: Vehicle Stability and Safety
Solution: Advanced Suspension Systems

- ARFF Vehicle Rollovers increasingly disturbing trend:
  - 48 between 1977 and 2002
  - 27 of those were between 1995 and 2002

- Although change in industry standard for new vehicle designs was evolving, retrofit design would be needed for thousands of existing ARFF vehicles
  - New apparatus design includes Independent Suspension System and other technologies designed to increase stability versus Solid Axles with Springs

- FAA Tech Center conducted Study “Evaluation of Retrofit ARFF Vehicle Suspension Enhancement to Reduce Vehicle Rollovers”
Advanced Suspension Systems

- ARFF vehicles must be responsive to large center of gravity shifts under high speed turning radius.
- Testing was conducted to define performance requirements for new standard:
  - Slalom Course
  - NATO Lane Change
Advanced Suspension Systems

- Test Vehicle equipped with outriggers to ensure safety
- Test Results showed that certain dynamic stability suspension systems reduce vehicle roll rates and body and chassis deflection
- Tilt Table test method used which was guided by SAE J2 180 test procedures
- At time of study, vehicle tested to $28^\circ$ established minimum angle on table; standard now revised to $30^\circ$
Most Effective Tool is Operator Training

- Lateral G Indicators provide audible and visual indicators of reduced stability
- Concern That Superior Ride Quality Diminishes Awareness
- Driver Training is Critical
  - NFPA 1002, Standard for Fire Department Vehicle Driver/Operator Professional excellent starting point for Lesson Plan

- Areas of concentration for ARFF Operations;
  - Pump & Roll  
  - Pump & Roll Reverse
  - Turret Range exercises  
  - Aiming exercises
  - HRET  
  - FLIR
  - Blind operation
Problem: Response in Low Visibility Conditions
Solution: Driver’s Enhanced Vision System (DEVS)

- In mid 1990’s FAA implemented Surface Movement Guidance Control Systems (SMGCS) to continue flight operations in very low visibility.

- Prior to DEVS, three major aviation accidents occurred in low visibility => ARFF response was affected.

- FAA Advisory Circular 150/5210-19 DEVS provides excellent overview of problem and technology (currently under FAA update).

- Integrated System comprised of following subsystem components:
  - Night Vision => Forward Looking Infrared (FLIR)
  - Navigation => Global Positioning System (GPS)
  - Tracking => Wireless Communication
Problem: Response in Low Visibility Conditions
Solution: Driver’s Enhanced Vision Systems (DEVS)

- Touch screen display provides operators with ability to enter a route on moving map and navigate in low/no visibility

- On/off course indicator, along with voice prompt, warns drive if off course

- In combination with FLIR, which shows obstacles in path, allow safe navigation to scene in poor visibility
Driver’s Enhanced Vision Systems (DEVS)

- Onboard computer and display avail storage and access of critical information from cab of vehicle

- Any file that can be saved electronically can be indexed, quickly referenced, and clearly illuminated on display

- Examples: Crash charts, Pre-fire plans, SOPs, Hydrant maps
Problem: Faster Extinguishment of Fire
Solution: High Reach Extendable Turret (HRET) and Piercing Devices

- FAA Testing compared P-19 roof turret with HRET in pooled fuel fire in same conditions as HPRV attack mode comparison tests
- Result: HRET in down-in-front position extinguished burn area an average of 53% faster
- Revert to training, come in low, attack low.
High Reach Extendable Turrets

- HRET and skin-penetrating nozzle evaluated at fire test facility outperformed the standard roof-mounted turret and hand line in all aspects:
  - Extinguished fire faster
  - Increased accuracy of firefighting agent application by positioning HRET close to the source of fire
  - Used less firefighting agent

- Other performance advantages:
  - Extended reach of HRET’s nozzle
  - Increase in firefighting agent throw range
  - Ability to reposition without moving vehicle
High Reach Extendable Turrets (cont’d)

- HRET with skin-penetrating nozzle, when used on full-scale fire field test using training aircraft:
  - Controlled and contained fire from spreading beyond tail section
  - Reduced high cabin temp from over 1500° to approx 250°
  - Provided rapid smoke ventilation and ability to extinguish fire
    - Less manpower-intensive and time-consuming versus traditional ventilation fans
  - Cabin conditions after spray discharge allowed fire fighters to enter aircraft

- Benefits can only be realized in hands of skilled, qualified operators!
HRET and Piercing Training

- No standard exists for training in HRETs and Piercing Devices
- ARFF Department needs to develop internal training program to qualify and re-qualify operators
- Training Officer qualifications must be established
- May be necessary to train operators from two positions
- Training methods range from basic training aids to full-size cab mock-ups with virtual training
HRET and Piercing Training (cont’d)

- Technology available from desktop PC via joysticks and controls identical to those in vehicle

- Training can be conducted during:
  - Daily check out / run up using an area marked off by cones and delineators
  - “T-ball competition”
  - Practice using section of tall chain link fence and colored ribbon

- Obviously best scenario is using aircraft fuselage
HRET and Piercing Training (cont’d)

- FAA Certalert # 0807 encourages hands on training in use of HRETs with skin penetrating nozzles

- When HRET purchased with AIP funds, purchase of following training aids also authorized via AC 150/5220-10D:
  - Eight days of training from manufacturer
  - “Aircraft Skin Penetrating Training Device”
  - CBT program
Familiarity with Interior Configuration

- ARFF Personnel should become familiar with interior configuration of each type of aircraft that normally operate at airport

- Recommended Piercing Points, Depth of Penetration, FLIR, Handheld Penetrators
Historical Aviation Accident Review

- UPS Airlines Flt. 1307, PHL, Philadelphia, PA

The following information was taken from the "NTSB Survival Factors/Airport And Emergency Response Group Chairman’s Factual Report, Docket NO. SA-228 EXHIBIT NO. 16A"

Summary:

- On February 7, 2006, at 2359 (EST), a Douglas DC-8-71F, N748UP, operated by United Parcel Service Company (UPS) as flight 1307, landed at Philadelphia International Airport (PHL), Philadelphia, Pennsylvania, after the crew reported a cargo smoke indication. The three flight crewmembers were able to evacuate the airplane using the L1 slide. Fire subsequently caused substantial damage to the airplane and numerous cargo containers on board. The three crewmembers received minor injuries.
UPS Flight 1307
Presented as Excellent Case Study

- There was no loss of life.

- The incident has been used by the aviation industry to highlight the need for ARFF Training on cargo aircraft.

- The Philadelphia Fire Department has taken the lead in effecting change. The PHL Chief has lectured extensively at ARFF venues to raise awareness to the lessons learned. PHL has developed a unique database to serve as a tactical tool for Incident Commanders, providing data they needed, but could not obtain on the day of the incident.
Fire Control Time

According to the City of Philadelphia Fire Department FCC dispatch logs, ARFF arrived at the accident site at 2359 local time. A period of 4 hours and 8 minutes elapsed from the initial arrival on scene to the time the incident commander radioed to dispatch for fire control (e.g., fire under control) (at 0407 local time).

(Editorial Comment) A control period of 4 hours is the first printed indication that the selected tactics were not effective.
Fire Conditions On-Scene

When ARFF vehicle arrived on-scene, no fire was visible, but smoke could be seen coming from the open L1 door and the outflow vent in the tail. The first indication of visible flame came when firefighters opened the right over wing emergency hatch. Flames were observed rolling on the fuselage ceiling over the tops of the cargo containers. Smoke began emanating from all open exits. All fire was located aft of the over wing exits toward the aft bulkhead. Burn through of the fuselage roof occurred at several locations between the trailing edge of the wing, aft toward the tail.

(Editorial Comments)
- No signs of significant fire
- No blistering of paint
- No visible deformity to the skin
- Based on the smoke report, a containable volume of fire
- First action was to open an over wing hatch which introduced oxygen

A similar level of effort may have been able to secure the open L-1 door, cutting off the source of oxygen.
Firefighting Strategy

The ARFF units surrounded the airplane and a water attack was ordered. Access to the main cargo area was obtained via the right over wing doors, and an exterior hand line attack was initiated from this location. Turret streams were applied into the R4 doorway while a Snozzle piercing operation was conducted on the left side. The piercing operation began behind the left aft over wing exit, in line with the windows, and continued aft toward the tail. The entire operation switched to a foam attack. Eventually hand lines were advanced to the interior of the airplane through the R4 and left side over wing doors until total extinguishment was completed.
Firefighting Strategy

(Editorial Comments)

- Streams were not effective in controlling fire, based on control time.
- If water directed to top of the fuselage, of which doors had been secured, metal could be kept cool. Cool metal does not melt.
- Reaction to water as it flows over metal is an excellent method of evaluating temperatures inside the aircraft. If water immediately turns to steam, in an area of the fuselage roof, that is area directly over fire.
- As time goes on and the fire uses available oxygen, amount of heat on fuselage roof should diminish and size of heated area of fuselage may diminish (good indicator of effectiveness).
- As outside resources arrive, aerial platform could be positioned to monitor activity and report conditions to Command Post. Thermal Imaging Camera (TIC) would be excellent tool to be used in monitoring position.
Hazmat Information Exchange

- Multiple Efforts / Conflicting Info
  - Unable to locate NOTOC
  - Firefighter threw NOTC out of Aircraft ??
  - UPS kept some of the contents, passed on the rest?
  - Ops tried to flag down UPS Officials.

Would CRM and ongoing Relationships have helped?
(Editorial Comments)

- Hazmat onboard was not a significant hazard to responders or the airport community.

- There was a greater danger created by the burning of aircraft components than by what might have been onboard.

- The report would seem to indicate that a significant level of effort and time was committed to tracking down the NOTOC.

- The conflicting reports would seem to suggest that all information was not being routed through the Command Post.
Water Supply

- IC sent Ops to locate closest hydrant.
- Police sent officer to check for hydrant locations on Hog Island Road as back up.
  - **Technology, Training, Planning, Experience**
Technology with Potential Benefits to Incident

- DEVS would have identified closest hydrant locations
- Working FLIR Cameras would have helped to locate hot spots
- DEVS of Mobile Data Terminals (MDTs) would have provided accurate crash chart for aircraft
- Proficiency in operation of Snozzle would have improved piercing attempt
Lessons Learned in “Smart Approach”

Lesson 1: Emergency Preparedness

- CRM – Teambuilding – Safety Partnerships provides ARFF with a support system, communications systems, resource sources, and an attitude of cooperation.

- AEPs, SOP’s, agreements and understandings all developed through the same methods with buy in from the stakeholders. All of this translates into success at the CP.
Lesson 2: Technology Integration

- MDT’s, DEVS or CP Fixed Equipment.
  - Aircraft Crash Charts, Configurations, PX or Cargo, Piercing Points, ERG’s

- FLIR / HRET & Hand Held Piercing Tools

- Tools / Technology / Training = Proficiency

- Interoperability of Mutual Aid & Technology
Lessons Learned in “Smart Approach”

Lesson 4: Maintain “Smart Approach”!

- Pressure from others who don’t understand ARFF methods can influence us to make decisions different than those guided by our training.

- **Bottom Line is that we must be:**
  - Well Prepared
  - Well Trained
  - Confident in our skills
Lessons Learned in “Smart Approach”

Lesson 3: Training

- ARFF is a Highly Specialized Fire Fighting Specialty

- Any Dept or Group that takes part in Airport Emergency Plan should have ARFF Training

- Never forget Original Training which provided basic skill sets
“Aviation in itself is not inherently dangerous, but to an even greater extent than the sea, it is terribly unforgiving of any carelessness, incapacity or neglect.”

C.R. Smith
Questions?

- This presentation and the paper from which it was derived, as well as all referenced documents, are available on my company website:

  www.APSSafety.net