Historical Overview - Licensee Assessments (Lessons Learned)

Frank Calcagno
FERC

San Francisco, CA January 27, 2004

Before we begin…

“How I spent my Holiday vacation away from the rigors of Dam Security…”


That’s me…
I believe that's the last of them. Excellent work, lads, bloody well done!
4 | 159


They have guards around here…
That's the Eder Dam…
That's me again…
Surveillance is important
3 | 50


Made it through the gate…
5 | 47

Took about a half hour
but I'm near the generator room now…

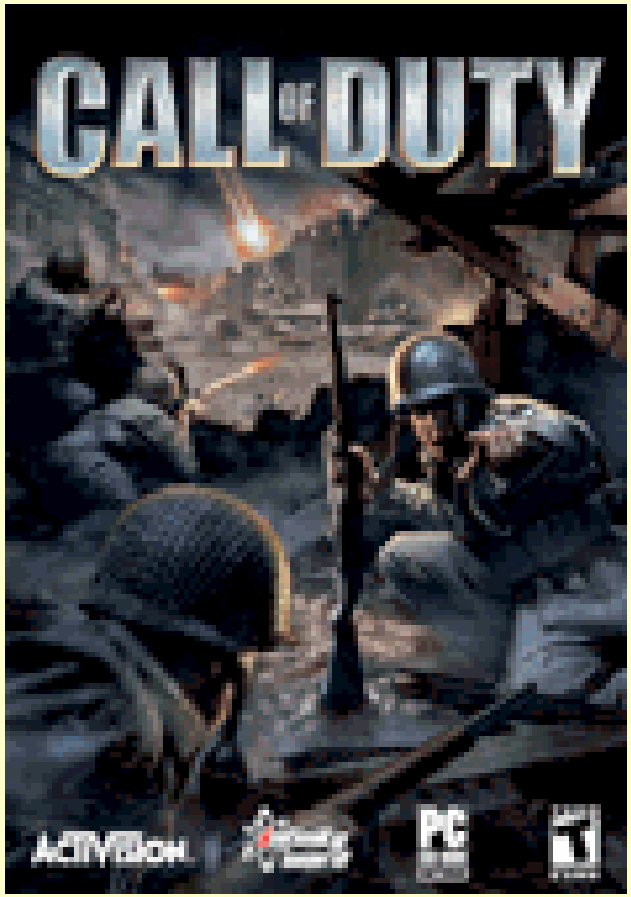

Turbines are spinning…
Needed to pick up a German MG…
32 | 185


The Control Room at the base…
19 | 253


Let’s plant the final charges…
17 | 320


And there she goes…
2 | 94

From:



SABOTAGE OF DAMS

To give you a historical perspective…what has been done at Dams in the past?

- **Two concrete gravity dams (184’ high Burguillo and 298’ high Ordunte) in Spain attacked (Spanish Civil War) in 1937 with 2.5-ton charge placed in an inspection gallery at Ordunte. No permanent damage resulted in either dam.**

Burguillo Dam

Ordunte Dam

Ordunte:
-First charge set at confluence of two lower galleries –
- **Some concrete damage in 15 x 5 x 3’ area**

-Set second charge in higher gallery

-No permanent damage

-Repaired 1938-1939

-Reasoned that galleries were located too far D/S

SABOTAGE OF DAMS

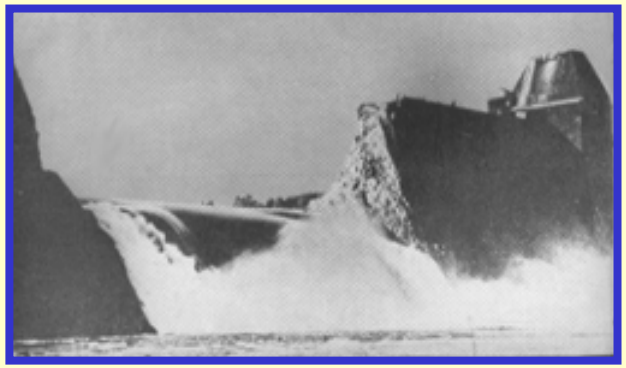
- **Dnjeprostroj Dam (131’ high concrete gravity) detonated with 90 tons (30 trucks with 3 tons of dynamite each) in a tunnel by Soviet troops retreating from Germans in 1941 caused a 660 foot wide breach. 200-ton concrete pieces were found 600 feet downstream. Discharge was 1.2 million cfs (50% greater than the design flood). The dam was repaired within 10 months.**

  Nine months later, the Germans sabotaged the dam as they left (this time it was damaged, but not breached).

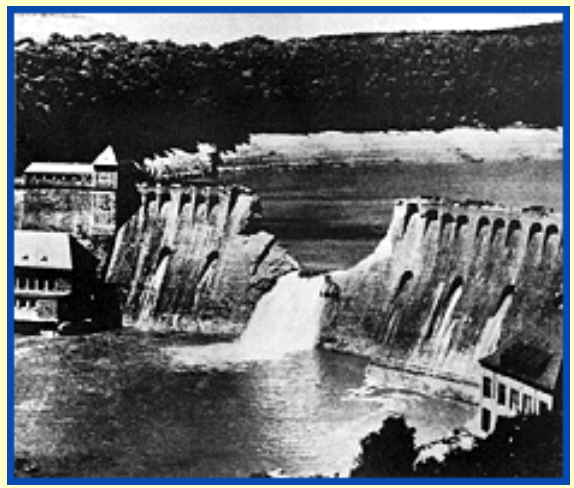
SABOTAGE OF DAMS

- **Two masonry dams in Germany (Mohne, 132’ and Eder, 157’) bombed by British in 1943 caused the death of 1,200 people. 9,250 pound skip (spinning cylindrical) bombs were used. Both repaired within 4 months.**

Mohne:
Breach: 253 x 72 feet
Discharge: 310,000 cfs
Wave: 33 feet high

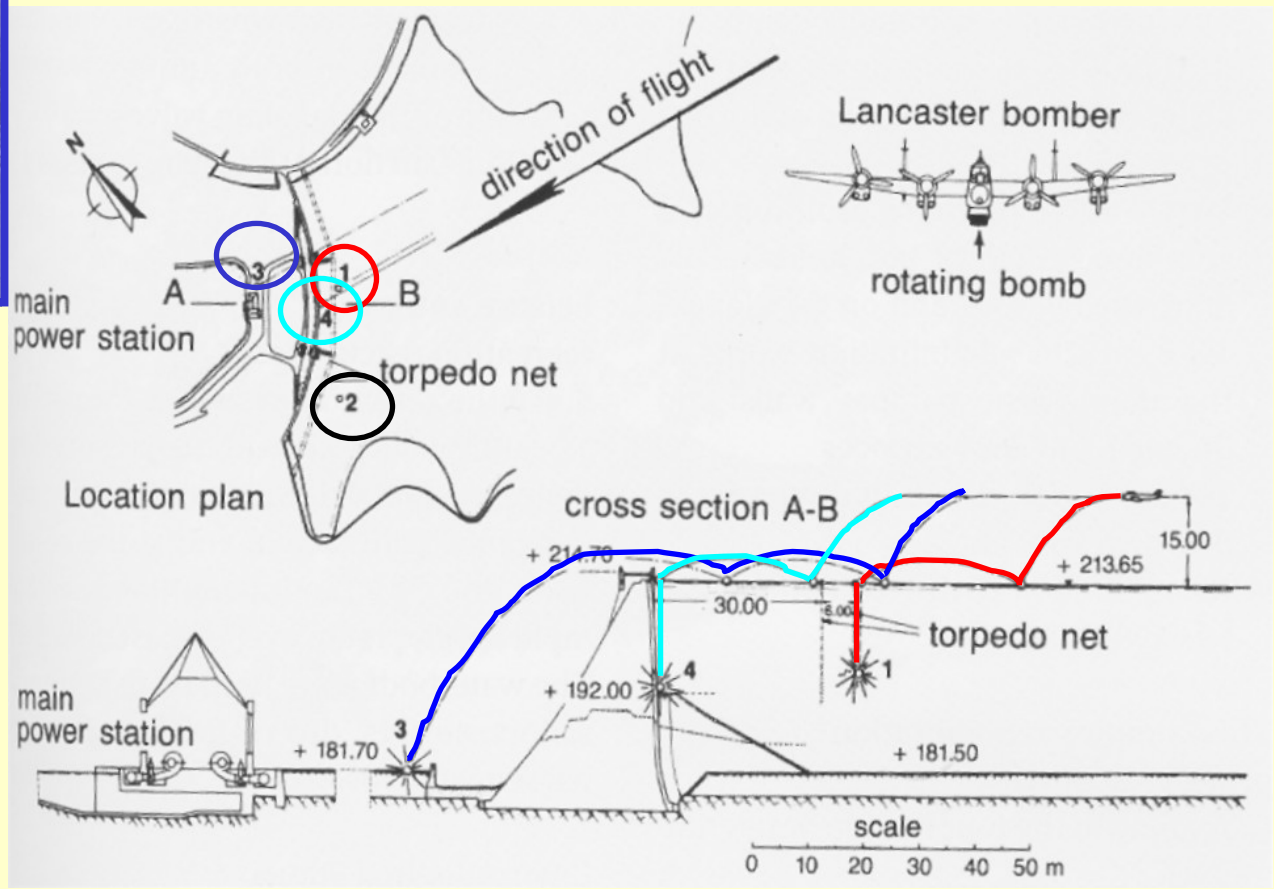


Eder:
Breach: 164 feet
Discharge: 300,000 cfs



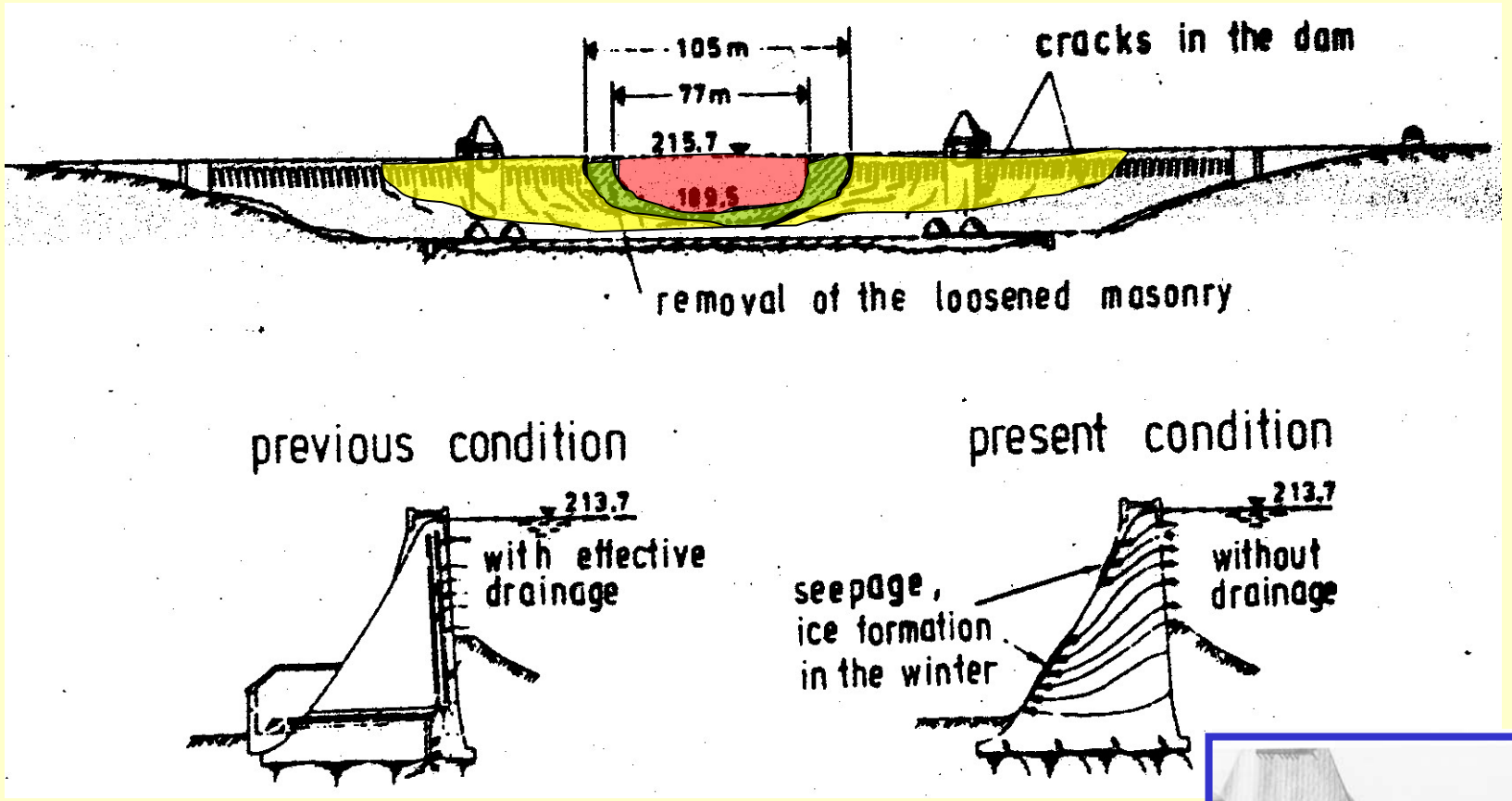
Photos on this and next slide from: www.dambusters.org.uk/dams.htm

SABOTAGE OF DAMS



Mohne Dam

SABOTAGE OF DAMS



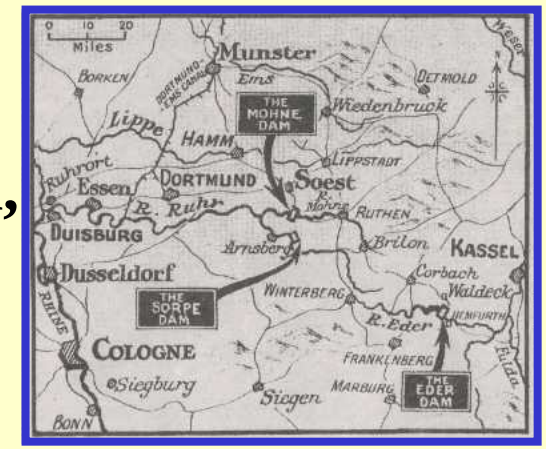
Mohne Dam

SABOTAGE OF DAMS

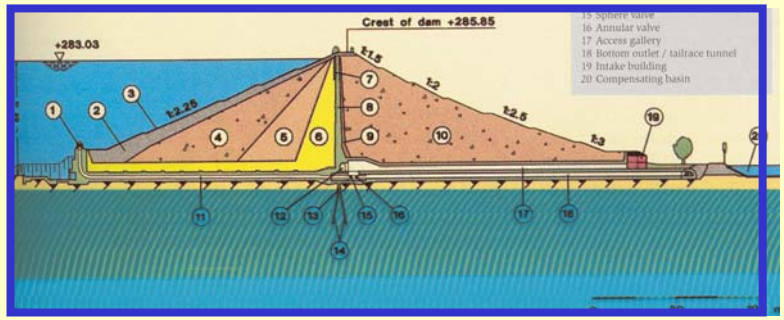
- **A third dam, the 226’ high earthfill Sorpe Dam, was also attacked at the same time as the Eder and Mohne. Two direct hits on its crest produced craters 40 feet deep, but the dam did not fail. It was bombed several more times and suffered 11 hits, but remained in service.**

The Sorpe showed strong surges of muddy water discharge in 1951 (then grouted) but settled 4.6 feet by 1956. The outlet was found to be broken upstream of the core. Voids in the concrete core were grouted, downstream bomb craters were filled, and the upstream face was paved (1962). Total grouting was 4350 tons of cement and 1700 tons of clay.

- **The Ennepe Dam (45’ high masonry gravity) also bombed, but not breached.**



SABOTAGE OF DAMS



Sorpe Dam

Ennepe Dam

SABOTAGE OF DAMS

- **266’ high Hwa Cheon Dam (concrete gravity) attacked and extensively damaged by both sides during the Korean conflict (six gates blown by North Koreans and hit by three 2,000-pound torpedoes by forces from the south). The dam was repaired after the Korean conflict.**

- **Sabotage suspected as the cause of the 1966 breaching of a dike impounding heavy metals near Vratza, Bulgaria. Dam collapse created a 15-foot high floodwave killing 96 people (possibly 600).**

SABOTAGE OF DAMS

- **197’ high Peruca Dam (rockfill) blasted at five locations in 1993 with 20-30 tons of TNT equivalent by Serbian forces during the Serbian-Croatian War. Charges were placed and the reservoir was raised as high as possible in 1991. UNPROFOR forces took control in 1992 and began lowering the reservoir. Adversaries took control again in 1993 and fired the explosives. Heavy damages occurred, but quick actions saved the dam. It was put back in operation in 1996.**

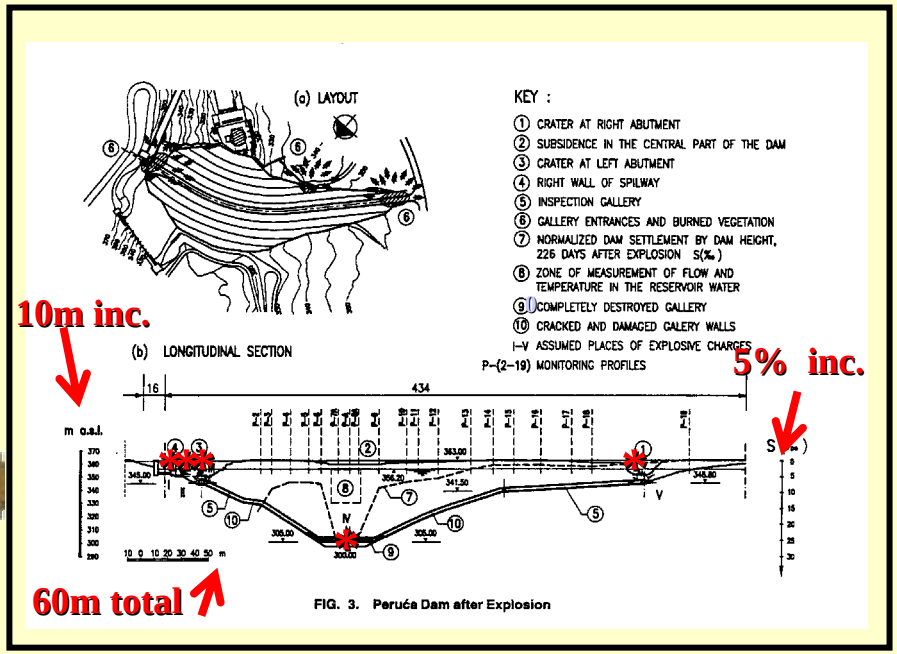


FIG. 3. Peruća Dam after Explosion

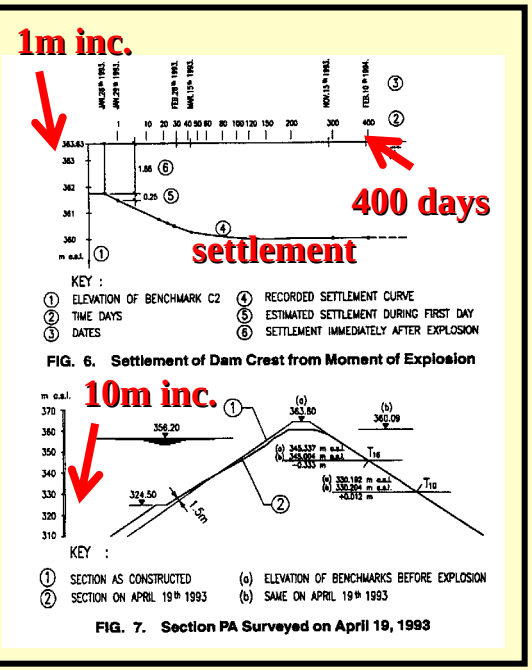


FIG. 6. Settlement of Dam Crest from Moment of Explosion

FIG. 7. Section PA Surveyed on April 19, 1993

SABOTAGE OF DAMS

At Peruca Dam, the damages were less than intended due to the following:

- **Gallery entrances were open, so explosive force shot out "like a cannon": trees felled in the path, vegetation set on fire.**

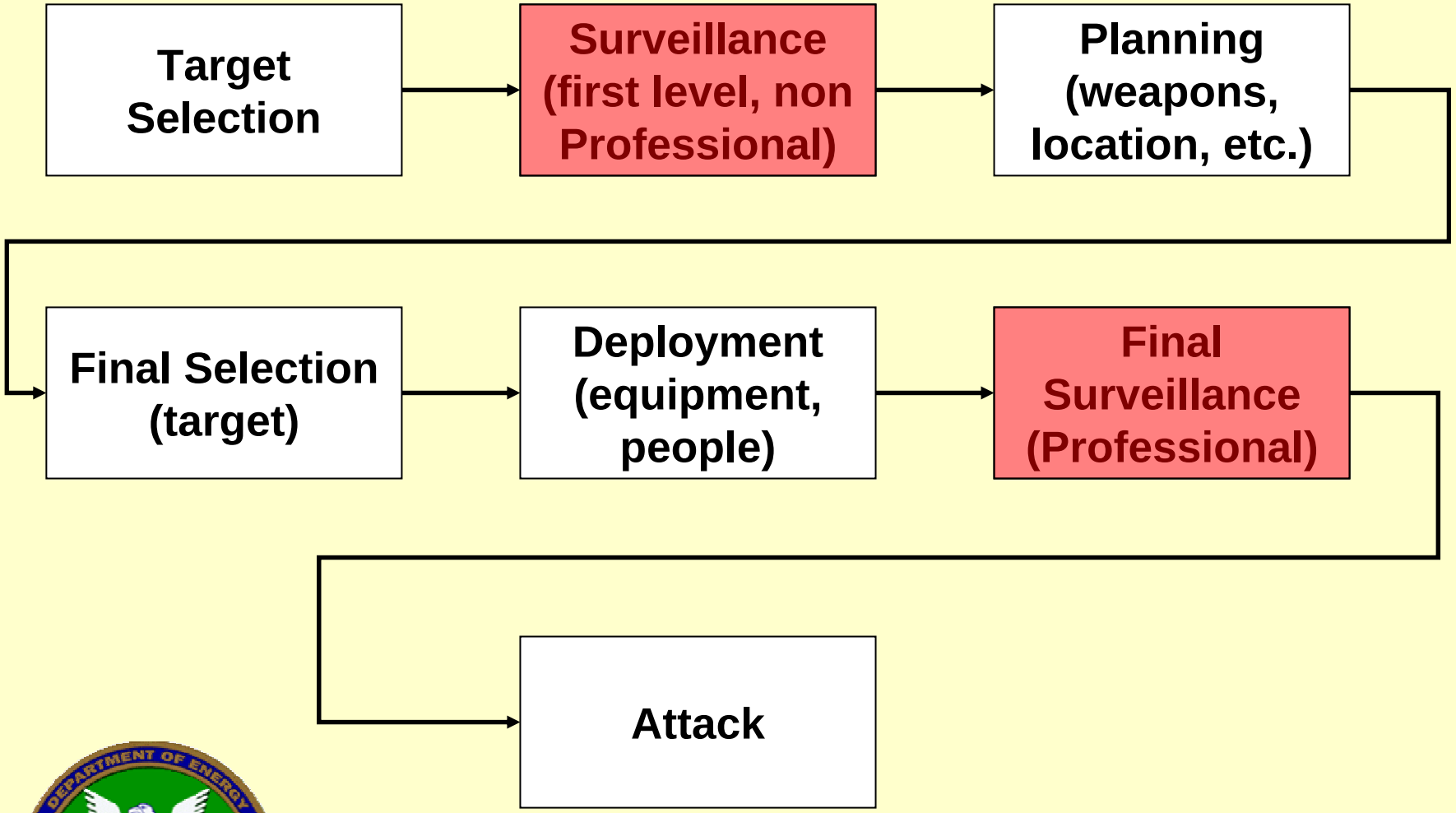
- **Reservoir was 15 feet lower than what the adversary intended; explosives failed to obstruct the spillway as intended.**

- **D/S rim of blast craters were 6.4 feet above the lake level and the reservoir never overtopped the dam.**

For further info: "Dams and Public Safety" by Robert Jansen (USBR, 1980); Jour. Geotech. & Geoenviron. Eng., April 1999; and internet searches.

In 2002, the FARC (narco-terrorists) attacked the 390' Chingaza Dam (concrete face), which provides water to nearly 10 million inhabitants of Bogotá, poisoned the aqueduct of Pitalito, and dynamited the aqueduct of Pasto.

POSSIBLE STEPS TOWARD A TERRORIST ATTACK (ES-ISAC, NIPC)



"You always got to get 'con' and 'recon.' You can't just say it was like that five days ago at all. Anything can change, construction or anything."

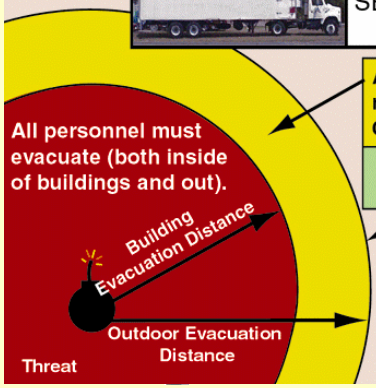
- Convicted D.C. Sniper Lee Boyd Malvo to Prince William Detective S. Walker

Terrorist Bomb Threat Stand-Off

THREAT	THREAT DESCRIPTION	EXPLOSIVES CAPACITY[1] (TNT EQUIVALENT)	BUILDING EVACUATION DISTANCE[2]	OUTDOOR EVACUATION DISTANCE[3]
	PIPE BOMB	5 LBS/ 2.3 KG	70 FT/ 21 M	850 FT/ 259 M
	BRIEFCASE/ SUITCASE BOMB	50 LBS/ 23 KG	150 FT/ 46 M	1,850 FT/ 564 M
	COMPACT SEDAN	500 LBS/ 227 KG	320 FT/ 98 M	1,500 FT/ 457 M
	SEDAN	1,000 LBS/ 454 KG	400 FT/ 122 M	1,750 FT/ 534 M
	PASSENGER/ CARGO VAN	4,000 LBS/ 1,814 KG	640 FT/ 195 M	2,750 FT/ 838 M
	SMALL MOVING VAN/DELIVERY TRUCK	10,000 LBS/ 4,536 KG	860 FT/ 263 M	3,750 FT/ 1,143 M

This card supersedes any previous undated versions 11/99

THREAT	THREAT DESCRIPTION	EXPLOSIVES CAPACITY[1] (TNT EQUIVALENT)	BUILDING EVACUATION DISTANCE[2]	OUTDOOR EVACUATION DISTANCE[3]
	MOVING VAN/ WATER TRUCK	30,000 LBS/ 13,608 KG	1,240 FT/ 375M	6,500 FT/ 1,982 M
	SEMI-TRAILER	60,000 LBS/ 27,216 KG	1,570 FT/ 475 M	7,000 FT/ 2,134 M



All personnel must either seek shelter inside a building (with some risk) away from windows and exterior walls, or move beyond the Outdoor Evacuation Distance.

Preferred area (beyond this line) for evacuation of people in buildings and mandatory for people outdoors.

[1] Based on maximum volume or weight of explosive (TNT equivalent) that could reasonably fit in a suitcase or vehicle.
[2] Governed by the ability of an unstrengthened building to withstand severe damage or collapse.
[3] Governed by the greater of fragment throw distance or glass breakage/ falling glass hazard distance. Note that pipe and briefcase bombs assume cased charges which throw fragments farther than vehicle bombs.

THE CURRENT (11/99) TSWG BLAST CARD

WHAT 1,010 POUNDS OF H.E. DETONATED IN A SCHOOL BUS LOOKS LIKE

KHOBAR TOWERS – TANKER TRUCK WITH 15,000 LBS. PLASTIC EXPLOSIVES: LEFT A CRATER MORE THAN 15 FEET DEEP

Security at Hydropower Projects

Licensees Completed Vulnerability/Security Assessments on Sept 30, 2003

- All Security Group 1 and Group 2 Dams (1,050) Completed Studies
  - Used to Assess and Upgrade Security Where Necessary
  - Used as Baseline for Future Needs

- FERC Engineers Will Continue Annual Security Inspections

Security at Hydropower Projects

Licensee/exemptee responsibilities:

Requirement	Security Group 1	Security Group 2	Security Group 3
Security Assessment	**Yes[1, 4]**	**Yes[1, 4]**	**No[2]**
Vulnerability Assessment	**Yes[1, 5]**	**No[2, 5]**	**No[5]**
Security Plan	**Yes[1]**	**Yes[1]**	**No[2]**
Integration of Security concerns and EAP procedures	**Yes[3]**	**Yes[3]**	**No[2]**

[1] Completed by September 30, 2003.
[2] Although not required, this item is strongly encouraged.
[3] Integration should begin immediately, and be revised as conditions change and documents are refined/developed.
[4] A separate Security Assessment may not be required for a dam if a more detailed Vulnerability Assessment is completed for that facility that addresses the need for security upgrades.
[5] A Vulnerability Assessment must be completed prior to the FERC approval of requests for permanent closures of recreational, or other project, facilities.

Operation Inspections

FERC will review any plans the licensee has while in the field. These include Security Assessments, Vulnerability Assessments, Security Plans, Recovery Plans, etc.

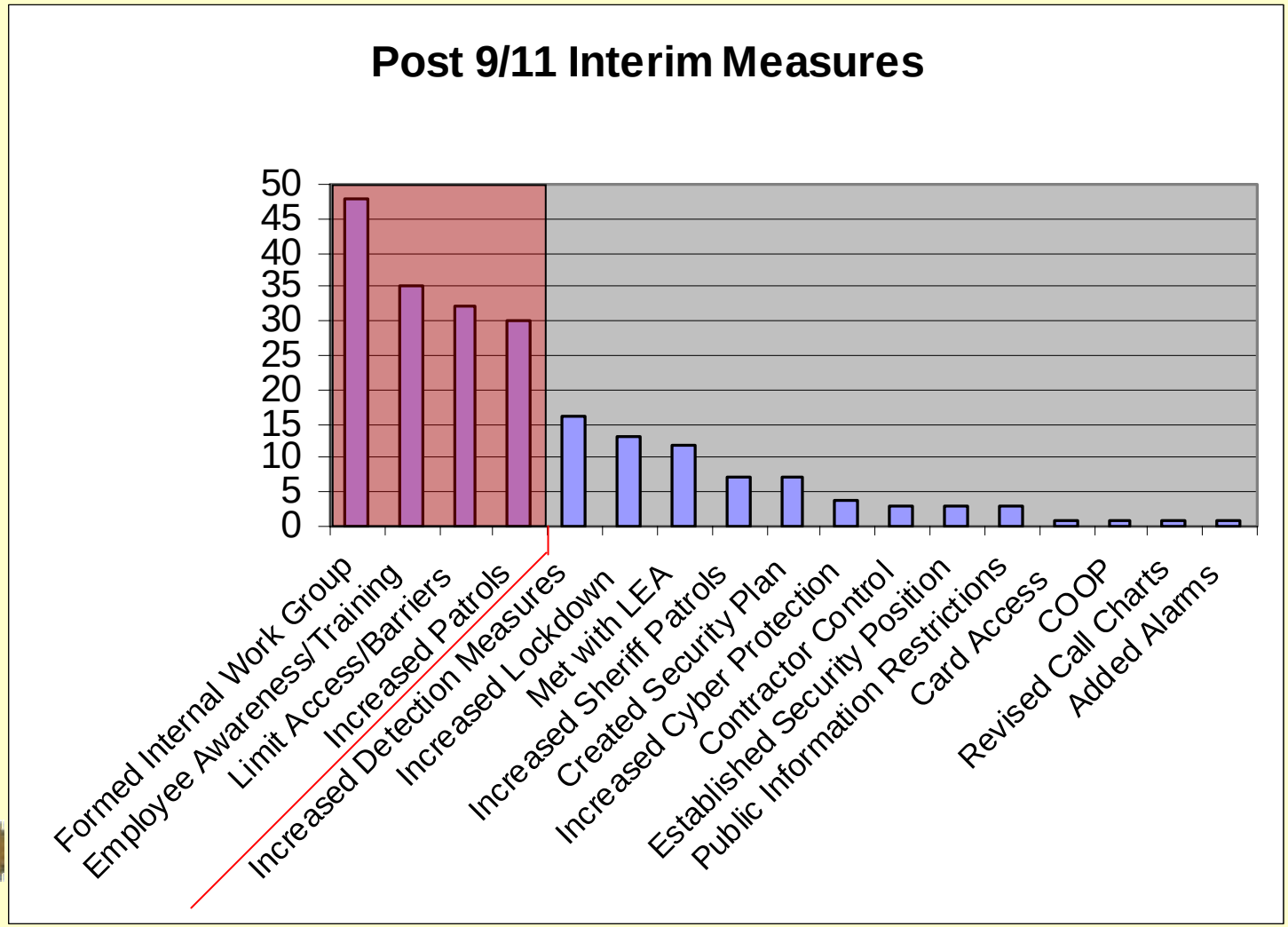
RESULTS OF LICENSEE VULNERABILITY/SECURITY ASSESSMENTS

FERC received 273 Summary Reports for the September 30, 2003 Deadline (many reports cover multiple dams).

The following are cumulative results learned from the submittals:

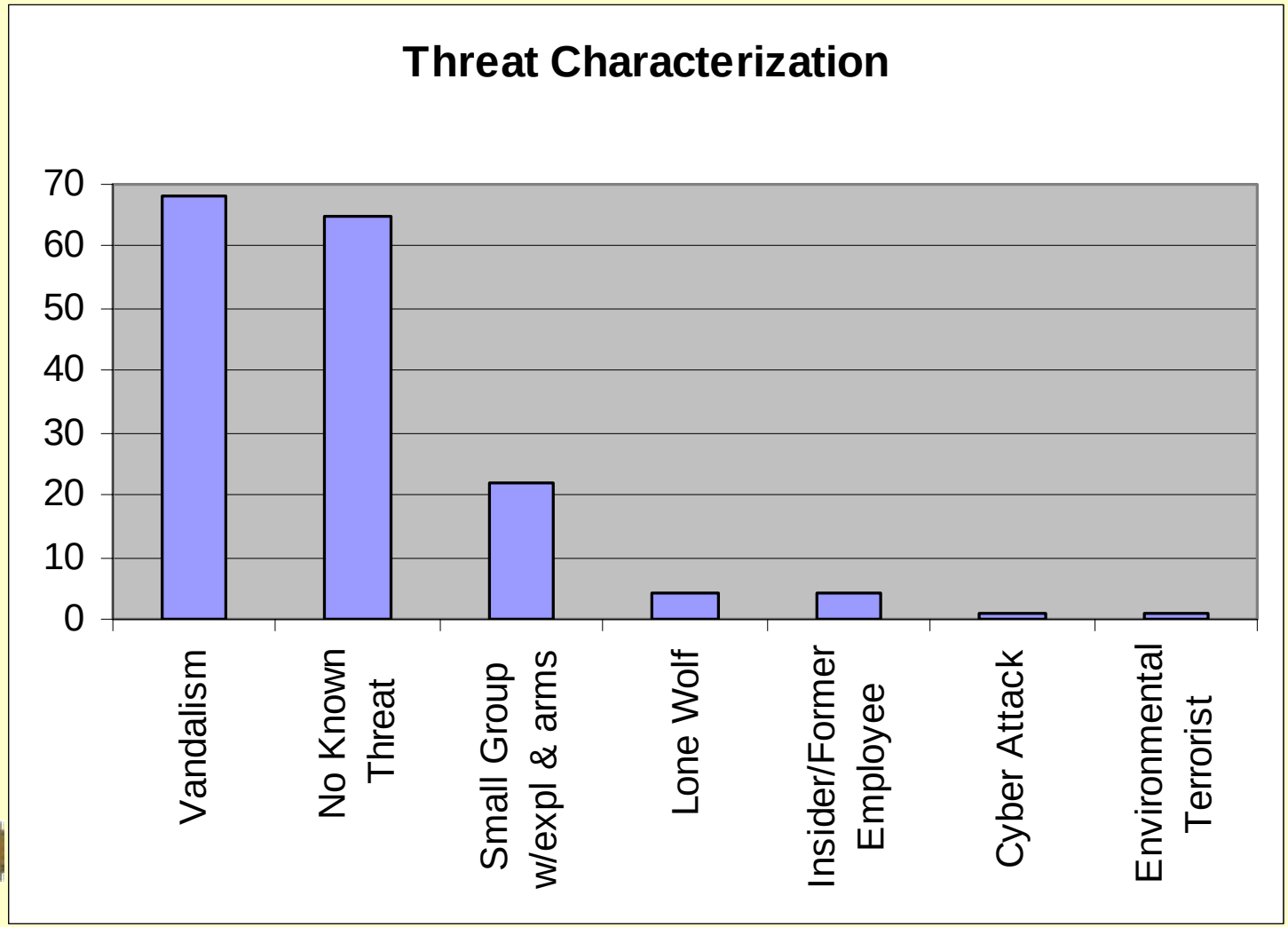
RESULTS OF LICENSEE VULNERABILITY/SECURITY ASSESSMENTS

Immediate Response to 9/11



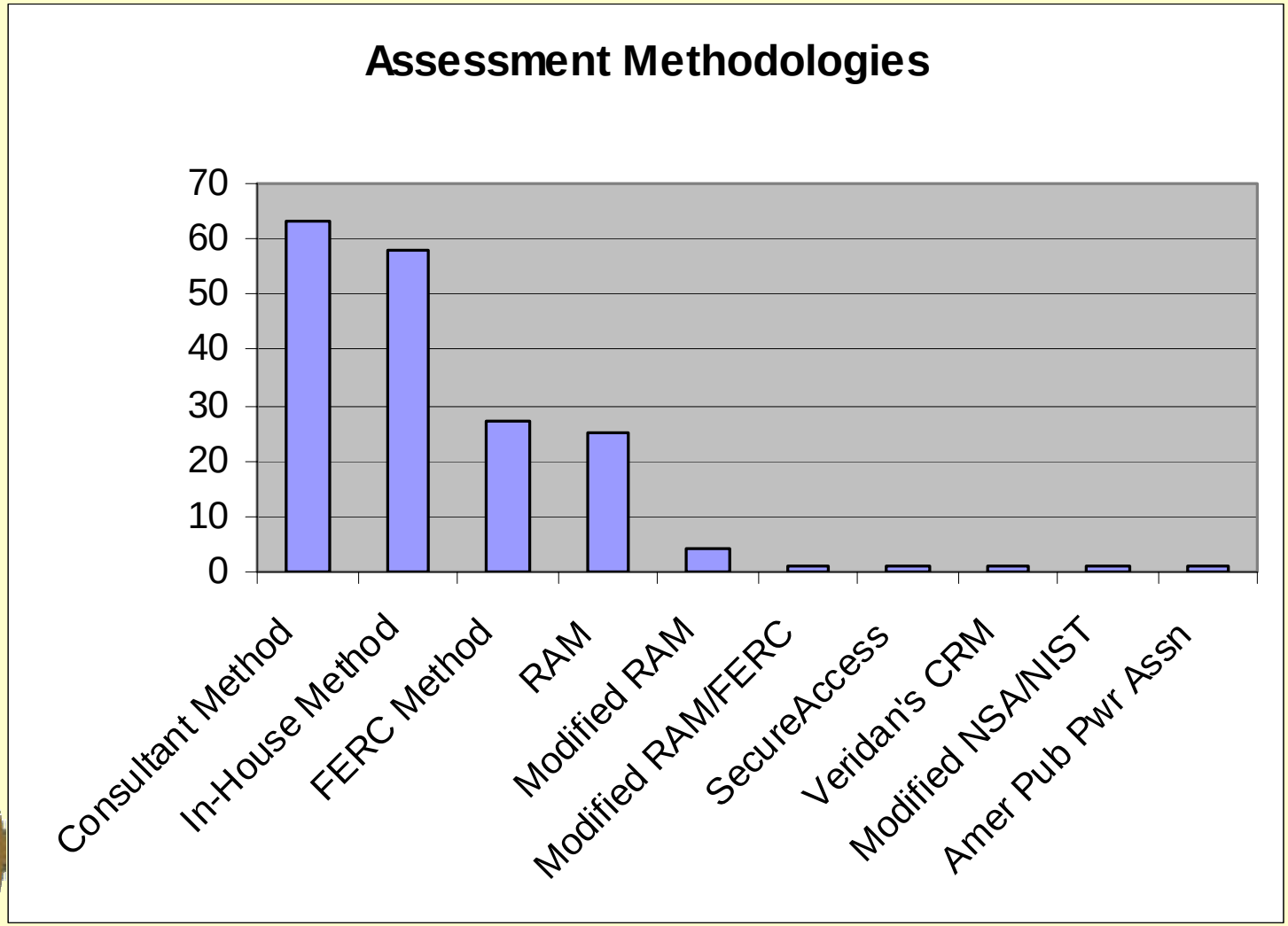
RESULTS OF LICENSEE VULNERABILITY/SECURITY ASSESSMENTS

What is the Perceived Threat?



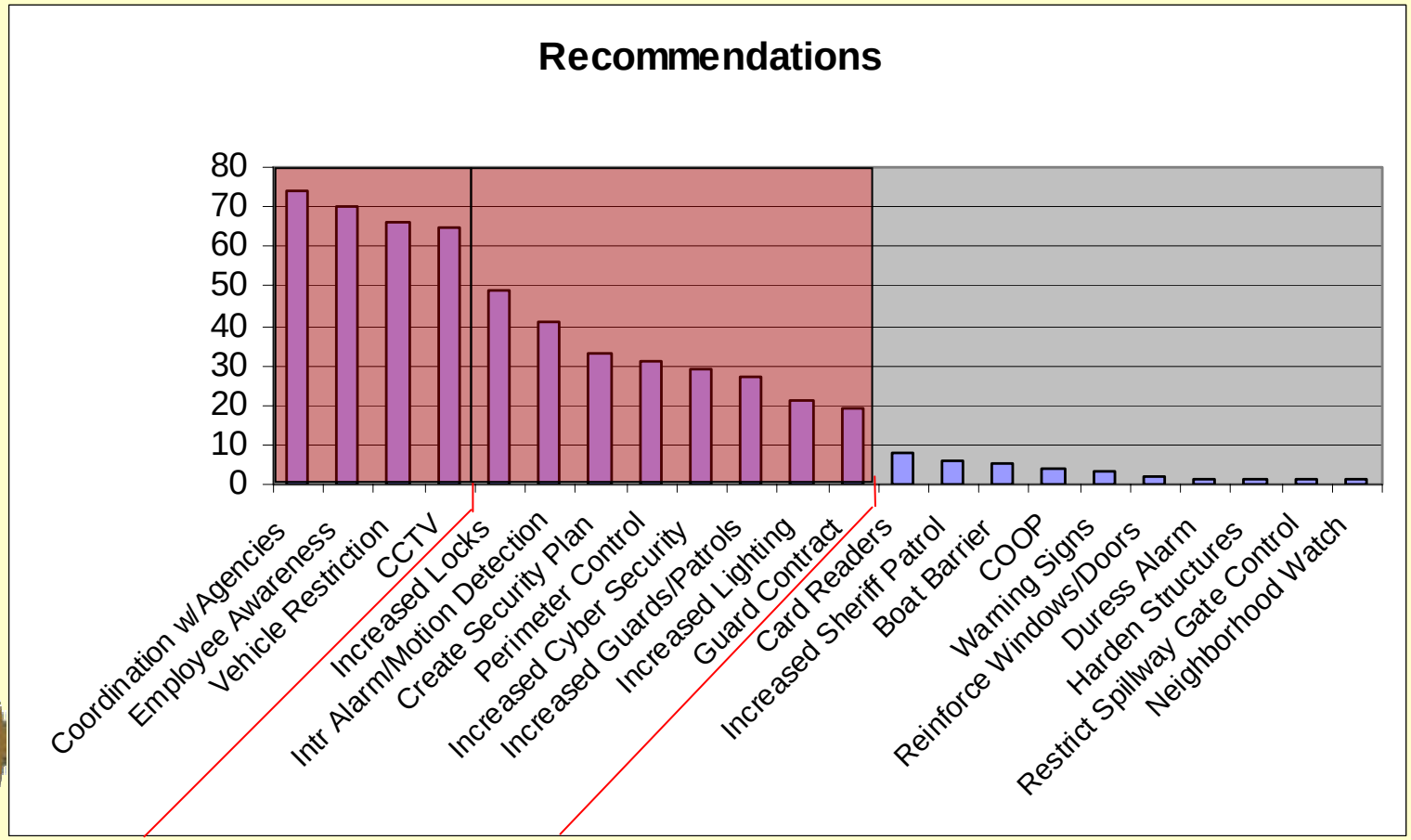
RESULTS OF LICENSEE VULNERABILITY/SECURITY ASSESSMENTS

What Assessment Methods Were Used?



RESULTS OF LICENSEE VULNERABILITY/SECURITY ASSESSMENTS

What Were the Suggested Upgrades Identified by the Assessments?



RESULTS OF LICENSEE VULNERABILITY/SECURITY ASSESSMENTS

Areas of Concern:

- Nuisance Break-in
- Explosion from Boats
- Attacks against Dam Structures
- Attacks against Spillway Gates
- Attacks against Powerhouse
- Attacks against Transformer Station
- Attacks against Step-up Transformers and Switchgears

Security at Hydropower Projects

Point of Discussion for this afternoon:

**Need for periodic re-assessment /
verification of existing Vulnerability/Security Assessments.**

This needs to be done: what are criteria / frequency?

Security at Hydropower Projects

Creation of a New Vulnerability Assessment Methodology for Dams

- Dam Assessment Matrix for Security and Vulnerability Risk (DAMSVR)
  - Coordinated Effort with FERC, USBR, USACE and ASDSO
  - Can be Used at all Dams
  - Will be Made Available to all Dam Owners and Consultants
  - CARVER Method (Army Special Ops)
- Will be Used by FERC Engineers to Verify Previous Studies

DAMSVR

1. Universal Tool/Simple to use/Applicable for all agencies.

2. Re-evaluatable.

3. Management Tool “Decision making tool”.

4. Critical Prioritization/Screening Tool (per dam, inventory, asset).

5. Vulnerability Assessment Tool.

6. Can be used by Owners, Regulators, Managers, Security Specialists.

DAMSVR Tables

CRITERIA	SCORE
Very High Massive loss of life is certain/very likely. National to Multi-region disruption of essential facilities and access. Economic Impact: Massive losses. (>$1B). Massive environmental mitigation cost or impossible to mitigate. Recovery over an extreme length of time.	9-10
High Many deaths. Loss of life is likely. Multi-regional disruption of essential facilities and access. Economic Impact: Multi-regional losses, ($100M to $1B) major public and private facilities. Very large environmental cost mitigation and multi year recovery.	7-8
Medium Loss of life is less likely. Regional disruption of essential facilities and access. Economic Impact: Regional losses, ($50M to $100M). Large environmental mitigation cost and 1 to 2 years to recover.	5-6
Low Loss of life is not likely/uncertain. Local to Regional disruption of essential facilities and access. Economic Impact: Local to regional (< $50M). Medium environmental mitigation cost and less than 1 year to recover.	3-4
Very Low No loss of life. No disruption of essential facilities and access. Economic Impact: Minimal and confined to facility only. Minor environmental mitigation cost.	1-2

Consequence Values (C) (Table 1)

Dam and Feature Vulnerability Ratings (V) (Table 2)

Dam Type[2,3]	Score	Hydropower Plants[4] # Units	Score	Features and Components[3] Redundancy	Score	Strength	Score
Thin Arch Ambursen/Slab and Buttress Embankment (<10 feet of freeboard)	9 – 10	Single Generating Unit	7 - 10	No Redundancy. Loss of one or more components of a single asset results in adverse consequences	9-10	No Reserve Strength. All asset components are easily destroyed	9 - 10
Embankment (10 to 15 feet freeboard)	7 – 8			Minimal Redundancy. Loss of a single asset may result in adverse consequences	7-8	Minimal Reserve Strength. Most asset components are easily destroyed	7 - 8
Masonry Gravity Embankment (16 to 20 feet freeboard)	5 – 6	Few Generating Units (2-3)	5 - 6	Moderate Redundancy. Loss of a single asset does not result in adverse consequences	5-6	Adequate Reserve Strength. Asset components are not easily destroyed	5 - 6
Concrete Gravity Embankment (21 to 25 feet freeboard)	3 – 4	Many Generating Units (4-6)	3 - 4	Redundant. Loss of a few identical assets does not result in adverse consequences	3-4	Moderate Reserve Strength. Asset components are difficult to destroy	3 - 4
Massive Concrete Gravity Massive Buttress Thick Arch Embankment (freeboard > 25 feet)	1 – 2	Very Many Generating Units (>6)	1 - 2	Highly Redundant. Loss of multiple identical assets does not result in adverse consequences.	1-2	High Reserve Strength. Asset component extremely difficult to destroy.	1 - 2

Notes:
1. The assessment team should determine vulnerability values as follows:
a) A single value for the dam type at the project. (A project may contain multiple dam structures and if so the dam type with the largest vulnerability re is used.)
A separate vulnerability value for all identified assets at the project. The aspects for asset vulnerability that should be considered are; number of ts, feature redundancy and relative component strength. For each separate asset, use the aspect with the highest score that is applicable to that et.
2. Experienced dam safety engineers should determine the vulnerability of dam types not shown on a case-by-case basis. Unusually wide or narrow dam cross sections may also justify an adjustment of vulnerability scores.
3. The dam and spillway vulnerability is dependent on the reservoir level. For sunny day considerations, the level should be the average annual maximum reservoir elevation. This will be determined by the primary purpose of the project. Hydropower reservoirs are kept at a constant level for most of the year so a normal reservoir level is more easily determined. Flood control reservoirs may fluctuate considerably during a typical year and a "rule curve" is used for a typical year. The reservoir level to be used for flood control reservoirs will be the average annual maximum pool based on the rule curve and is usually defined as a 2-year return period level. A dam, however, may be highly vulnerable during flood or seasonal periods of high pool levels and the security assessment should consider the possibility of an attack during those periods.
4. The primary emphasis for power plants is redundancy. A plant with many generating units is impacted less by one unit going off-line than a plant with few units. The total capacity of the power plant and the criticality of the plant to the local or regional grid are accounted for in the

CRITERIA	SCORE
Very High: An attack on this critical asset is very likely to succeed because it is easy to identify and access; is highly vulnerable; requires minimal resources to damage, destroy, or open the critical asset; and is an attractive target.	9-10
High: An attack on this critical asset is likely to succeed. Access can be achieved fairly easily to the asset and has significant vulnerabilities that take only moderate amounts of resources to destroy or damage and has some attractiveness as a target.	7-8
Moderate: An attack on this critical asset has only a moderate chance of success. The asset can be damaged or destroyed with moderate effort, but access is through multiple barrier features that require significant resources and is somewhat of an attractive target.	5-6
Low: This critical asset is not an attractive target and/or any attack has a low chance for success. The asset is difficult to access and requires sophisticated knowledge and equipment to damage or destroy.	3-4
Very Low: This rating indicates the critical asset is very unattractive and an extremely improbable target. There is virtually no chance of success attacking this asset given the low vulnerabilities, the very large amount or sophistication of resources required, and the difficulty of access.	1-2

Probability of Loss (L) Rating (Table 3)

DAMSVR Tables

Consequence Category	LOSS FACTOR (Vulnerability x Probability of Loss)					Category Definitions
	Very Likely	Likely	Less Likely	Unlikely	Very Unlikely	
	100 to 81	80 to 61	60 to 41	40 to 21	20 to 1	
Very High	1	2	3	5	8	Massive loss of life certain/very likely. National to Multi-region disruption of essential facilities and access. Economic Impact: Massive losses. (>$1B). Massive environmental mitigation cost or impossible to mitigate. Recovery over an extreme length of time.
High	4	6	7	9	13	Many deaths. Loss of life likely. Multi-regional disruption of essential facilities and access. Economic Impact: Multi-regional losses, ($100M to $1B) major public and private facilities. Very large environmental cost mitigation and multi year recovery.
Medium	10	11	12	14	16	Loss of life less likely. Regional disruption of essential facilities and access. Economic Impact: Regional losses, ($50M to $100M). Large environmental mitigation cost and 1 to 2 years to recover.
Low	15	17	18	19	20	Loss of life unlikely/uncertain. Local to Regional disruption of essential facilities and access. Economic Impact: Local to regional (< 50M). Medium environmental mitigation cost and less than 1 year to recover.
Very Low	21	22	23	24	25	No loss of life. No disruption of essential facilities and access. Economic Impact: Minimal and confined to facility only. Minor environmental mitigation cost.

ble 5 – Priority Rating

LOSS FACTOR RATING (from Table 4)	PRIORITY
1 to 5	Highly Probable
6 –10	Probable
11-15	Moderately Probable
16-20	Improbable
21-25	Extremely Improbable

Determine Loss Factor Rating (LF)
Determine Priority Rating
(Tables 4, 5)

CRITERIA	SCORE
Very High: Demonstrated capability exists to compromise the critical asset identified. Known to have means, resources, tactical and technical skills to conduct coordinated operation/assault on one or more critical assets. Evidence exists to show carefully planned operations and/or vulnerability of assets makes success of an attack to be highly achievable.	9-10
High: Demonstrated capability in the tactics required to compromise critical asset, but lack resources and tactical skills to successfully attack critical asset. Limited planning skills and tactical and technical knowledge suggest a potential for a successful attack and compromise of the critical asset. Attacks, if any, have been well coordinated showing a clear objective in mind.	7-8
Moderate: Suspected of having capabilities or some known capability exists to use tactics necessary to compromise critical asset; however limited evidence of a capability to acquire knowledge and resources for a successful attack. Histories of attacks, if any, show a basic level of coordination and appear to have a common theme.	5-6
Low: Suspected presence, marginal capability based on demonstrated activities and limited ability to acquire skills and resources to successfully attack asset. Attacks, if any, show some coordination, but primarily spontaneous in nature.	3-4
Very Low: Little organization and no history of planned or orchestrated attacks. Capability not yet demonstrated to be successful on any level. Attacks are random.	1-2

Footnote: The narrative within each cell in the Threat Table is designed to be a guide. The nature of threat is difficult to capture in a table. Variables such as the amount of intelligence preparation (surveillance, drawings, planning, and photography) that is required to initiate an attack and the intangibles of an insider threat (job dissatisfaction, opportunity for collusion or blackmail) all should be incorporated into determining the appropriate value. The narrative should not replace the guidance and opinion of an experienced threat specialist; it should complement him or her.

Determine Threat to Asset (T) (Table 6)

Determine Security Effectiveness (S)
(Table 7)

CRITERIA	SCORE
No Detection exists	9-10
Detection exists with no or ineffective Assessment capabilities.	7-8
Detection exists with Assessment capabilities but insufficient Delay exits to allow for adequate Response and/or the implementation of Mitigation measures.	5-6
Detection exists w/Assessment where Delay is greater than or equal to Response but low confidence in the overall Integration of the security systems.	3-4
Detection, Assessment, Delay, Response, and Integration of the overall security system works well to protect the critical asset of the project and good Mitigation measures are in place.	1-2

DAMSVR Overview

$$ASR = C*(V+L+T+S)$$

- ✓ Consequence of Loss **(C)**
- ✓ Vulnerability **(V)**
- ✓ Probability of Loss **(L)**
- ✓ Specific Threat **(T)**
- ✓ Security System **(S)**

$4 \leq ASR \leq 400$ (28 to 400)

More detail about DAMSVR will be presented during the Friday morning Overview Session.

Further discussions about Threat, Communication/Coordination, and EAPs will be continued tomorrow afternoon.

“…Andy…We got him!”

Historical Overview - Licensee Assessments (Lessons Learned)

Questions?

Frank Calcagno
FERC

San Francisco, CA January 27, 2004