EXPERIENCE WITH INFRARED LEAK DETECTION OF FPL SWITCHGEAR

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"SF_6 LEAK DETECTION"

Sulfur hexafluoride (SF_6) is a "greenhouse gas" that is used extensively in power industry equipment. With age equipment leaks. Traditional leak detection methods have not been adequate.

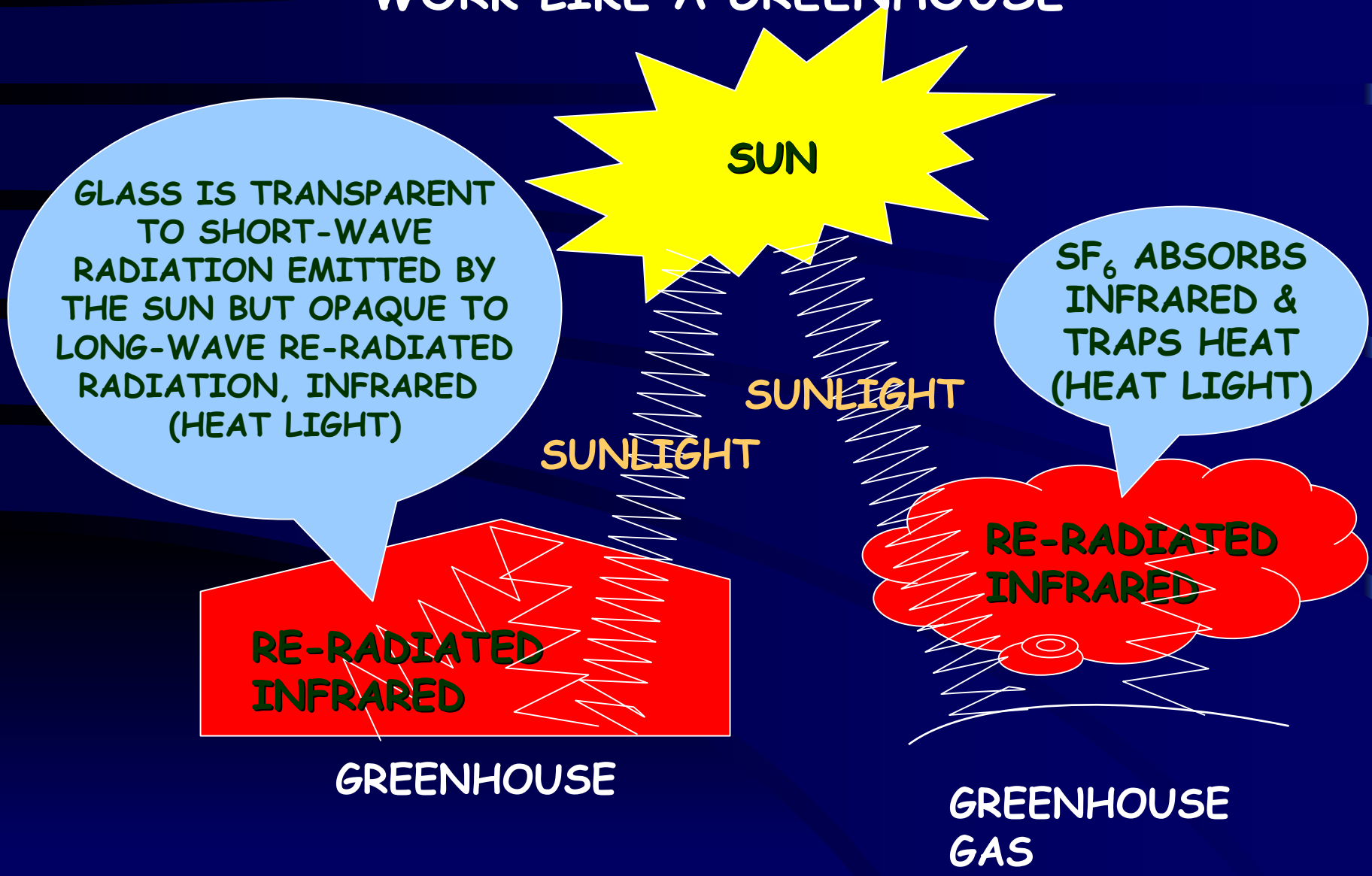
The Environmental Protection Agency (EPA) is interested in controlling the release of SF_6. On April 13, 1999, FPL joined an "SF_6 EMISSIONS REDUCTION PARTNERSHIP" with the EPA.

The partnership requires that FPL:

- Maintain ACCURATE INVENTORY Of SF_6
- MONITOR and REDUCE the OVERALL LEAK RATE
- Implement SF_6 RECYCLING
- Tightly MANAGE the Use of SF_6
- Yearly reporting of SF_6 EMISSIONS

GREEN HOUSE GASES

WORK LIKE A GREENHOUSE



"SF_6 LEAK DETECTION"

CURRENT SITUATION:

PARTNERS MUST DEAL WITH TWO FUNDAMENTAL ISSUES

- HOW TO EFFECTIVELY MANAGE & DOCUMENT SF_6 USE
- HOW TO EFFECTIVELY DETECT AND HANDLE SF_6 LEAKS

"SF_6 LEAK DETECTION"

ANALYSIS:

ECONOMIC DECISION MODELS WERE DEVELOPED TO DETERMINE:

SHOULD WE INVEST IN LEAK DETECTION EQUIPMENT & PERFORM THE SERVICE INTERNALLY, OR "OUTSOURCE"?

A FIVE YEAR PRESENT WORTH ANALYSIS REVEALED SIGNIFICANT ADVANTAGES IN "OUTSOURCING"

"SF_6 LEAK DETECTION"

ANALYSIS:

A MANAGEMENT INTERACTION DIAGRAM WAS FIRST DEVELOPED TO AID IN DEFINING STRUCTURE, PROCEDURES, AND BID SPECIFICATIONS

CORPORATE PHILOSOPHY WAS THEN AGREED TO ACROSS ALL AFFECTED DEPARTMENTS

"SF_6 LEAK DETECTION"

MANAGEMENT INTERACTION

INVENTORY SERVICES:
- Inventories all incoming SF_6
- Purchases
- Reclaimed
- Inventories all issues of SF_6

GAS MANAGEMENT "CONTRACTOR"
- Fill new breakers
- Reprocess SF_6 during maintenance
- Remove, reprocess, & reclaim SF_6 gas during decommissioning
- Test & certify processed gas for return to stores
- Perform administrative tracking

MATERIAL MANAGEMENT SYS.
Track & quantify movement of SF_6 gas:
- **In-service inventory of SF_6**
- **Purchased SF_6**
- Issued SF_6
- Sold SF_6
- Inventory transfers of SF_6
- Reprocessed SF_6
- Stored SF_6 inventory

STATIONS
Schedules contractor through env.:
- Normal maintenance
- New installations (filling & leak detect)
- Emergency response

Develops annual leak detection strategy
- Develops annual repair strategy
- Tops off leaking breakers

POWER SYSTEMS ENVIRONMENTAL.
- Administers SF_6 contractors
- Coordinates overall SF_6 management
- Handles "emergency response"
- Compiles annual SF_6 analysis

LEAK DETECTION CONTRACTOR
- Checks for leaks on new breaker installations
- Performs routine leak detection services

CORPORATE ENVIRONMENTAL SERVICES
- One point contact for the EPA-MOU
- Prepares "Emissions Inventory Form"
- Prepares first year MOU requirements

"SF_6 LEAK DETECTION"

CORPORATE PHILOSOPHY:

- ALL NEW BREAKERS WILL BE LEAK CHECKED
- THE EXISTING SF_6 POPULATION WOULD BE LEAK CHECKED
- EQUIPMENT NEEDING PERIODIC TOPPING-OFF WILL BE LEAK CHECKED
- PERMANENT FIXES ARE PREFERRED OVER TEMPORARY REPAIRS (EPOXIES, ETC.)
- GAS IMAGING TECHNOLOGY WILL BE USED

"SF_6 LEAK DETECTION"

ANALYSIS:

TRADITIONAL METHODS SUCH AS SNOOPING, SNIFFING, ETC., WOULD NOT PROVIDE ADEQUATE RESULTS ACROSS THE POPULATION OF INTEREST AND WITHIN THE TARGETED TIME WINDOW

BACK-SCATTER ABSORPTION GAS IMAGING (BAGI) COULD MEET THESE REQUIREMENTS

"SF_6 LEAK DETECTION"

ANALYSIS:

BACK-SCATTER ABSORPTION GAS IMAGING (BAGI) WAS ORIGINALLY DEVELOPED BY LAWRENCE LIVERMORE NATIONAL LABORATORY FOR THE NAVY

DURING INITIAL SURVEILLANCE OF DISABLED MARINE VESSELS THE NAVY NEEDED TO KNOW IF THE ATMOSPHERIC ENVIRONMENT WAS SAFE; THIS NEED DROVE THE DEVELOPMENT OF BAGI

THE SYSTEM HAS BEEN PATENTED UNDER BAGI TECHNOLOGY (US PATENT #4.555.627)

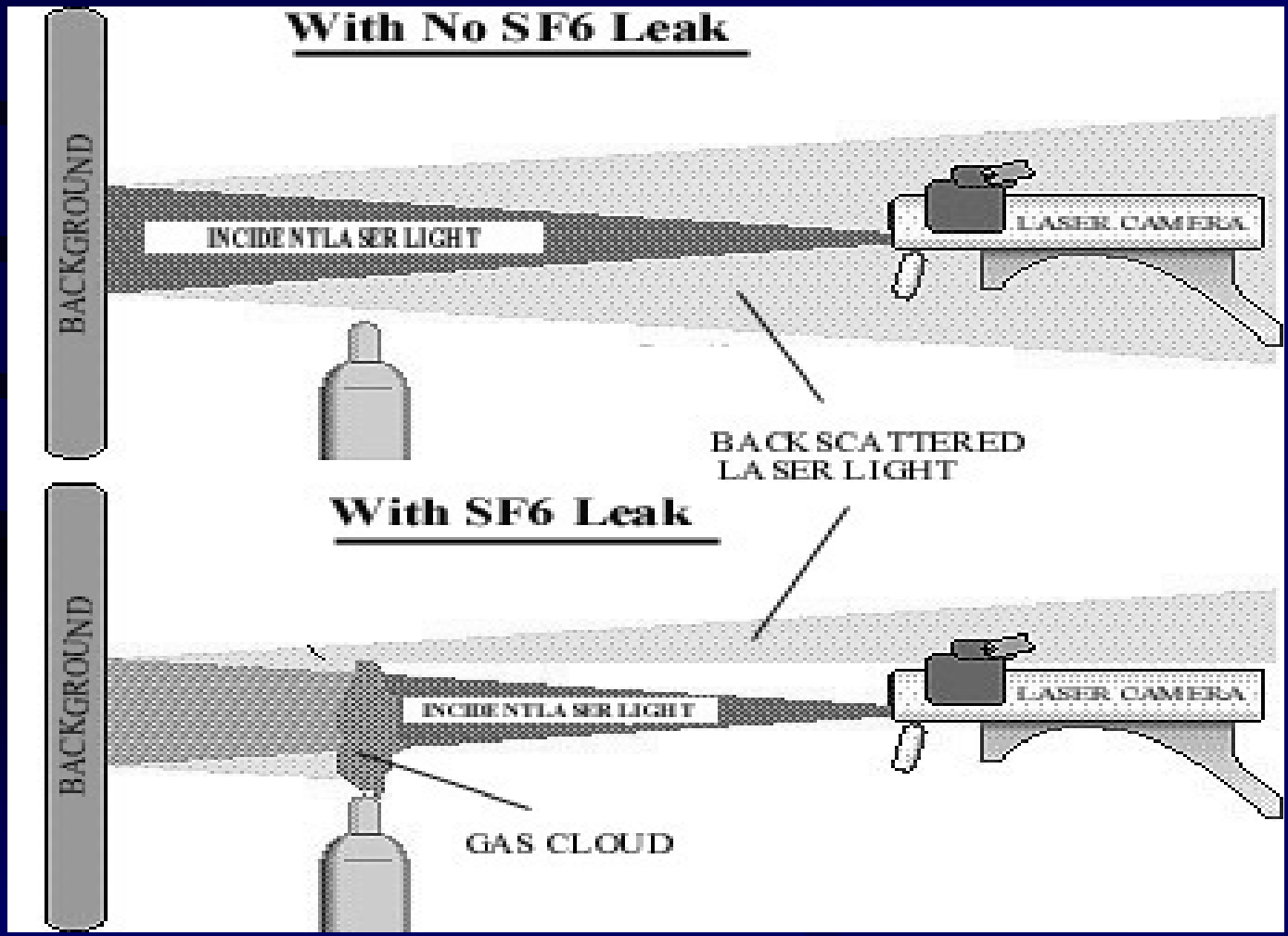
"SF_6 LEAK DETECTION"

HOW IT WORKS:

THE SYSTEM USES AN **INFRARED LASER** TO ILLUMINATE AN OBJECT. A CAMERA TUNED TO FILTER OUT ALL BUT THE BACK-SCATTERED INFRARED LIGHT (REFLECTED LIGHT) PRODUCES A VIDEO IMAGE OF THE SPECIMEN. INFRARED IS ABSORBED BY SF_6 AND PRODUCES A **DARK IMAGE** AT THE LOCATION OF ANY SF_6 GAS CLOUD.

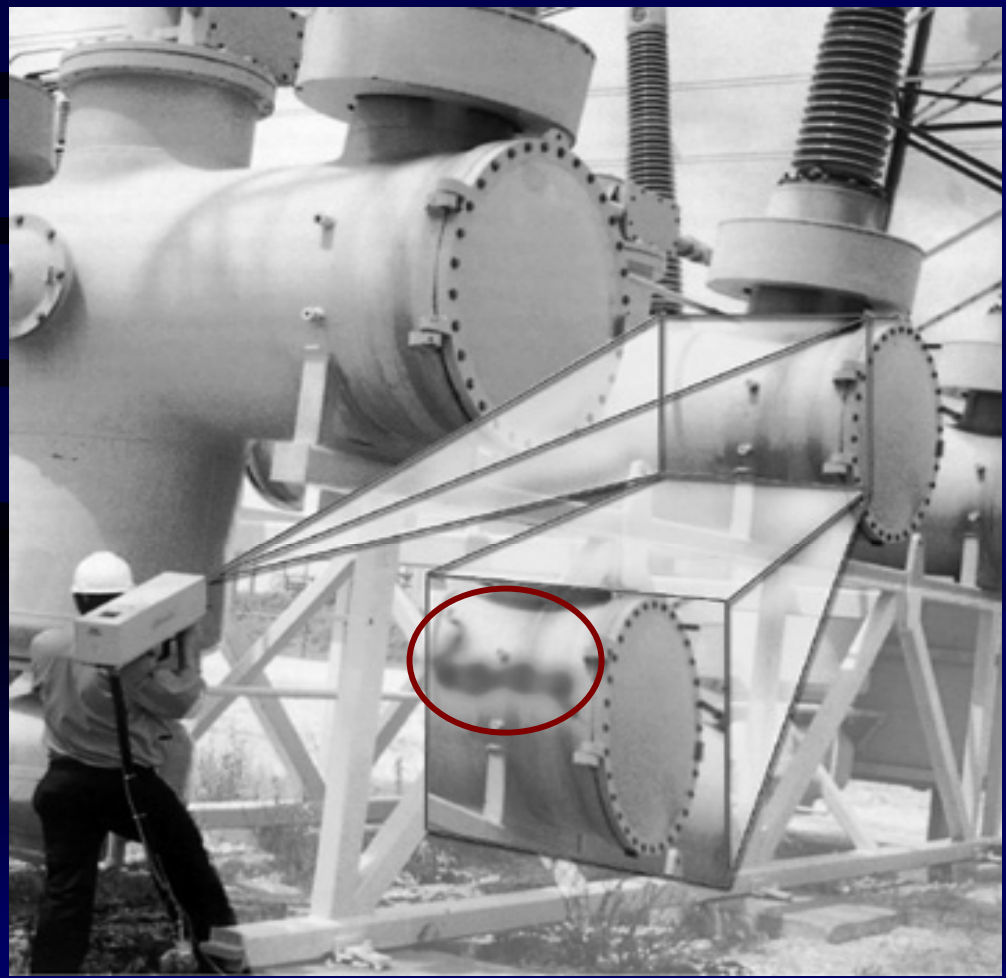
"SF_6 LEAK DETECTION"

HOW IT WORKS:



"SF_6 LEAK DETECTION"

FIELD RESULTS:



Performance limits:

- Range is 20 to 30 meters
- Must be a "reflective" or "back-scattering" surface
- Excessive background SF_6 may obscure the leak
- "Best results" obtained with leak as close as possible & incident "beam perpendicular to SF_6 plume"

"SF_6 LEAK DETECTION"

FIELD RESULTS:

Current machines:

- Use CO_2 laser power & a video imaging camera
- The base unit & camera are bulky but research is being done to reduce its size

"SF_6 LEAK DETECTION"

RESULTS:

- IN APPROXIMATELY 4 MONTHS THE "LEAK DETECTION CONTRACTOR" HAD COMPLETED LEAK DETECTION OF 460 SF_6 BREAKERS
- 9% (40 BREAKERS) OF THE BREAKER POPULATION WERE FOUND WITH DETECTABLE LEAKS
- 15% OF THE LEAKS WERE MINOR (LOOSE FITTINGS, ETC.) AND WERE CORRECTED ON SITE BY THE "LEAK DETECTION CONTRACTOR"
- 85% OF THE LEAKS WERE SIGNIFICANT AND HAD TO BE REFERRED TO "OPERATIONS " FOR SCHEDULED REPAIRS
- 5% OF THE LEAKING BREAKERS WERE IN WARRANTY

"SF_6 LEAK DETECTION"

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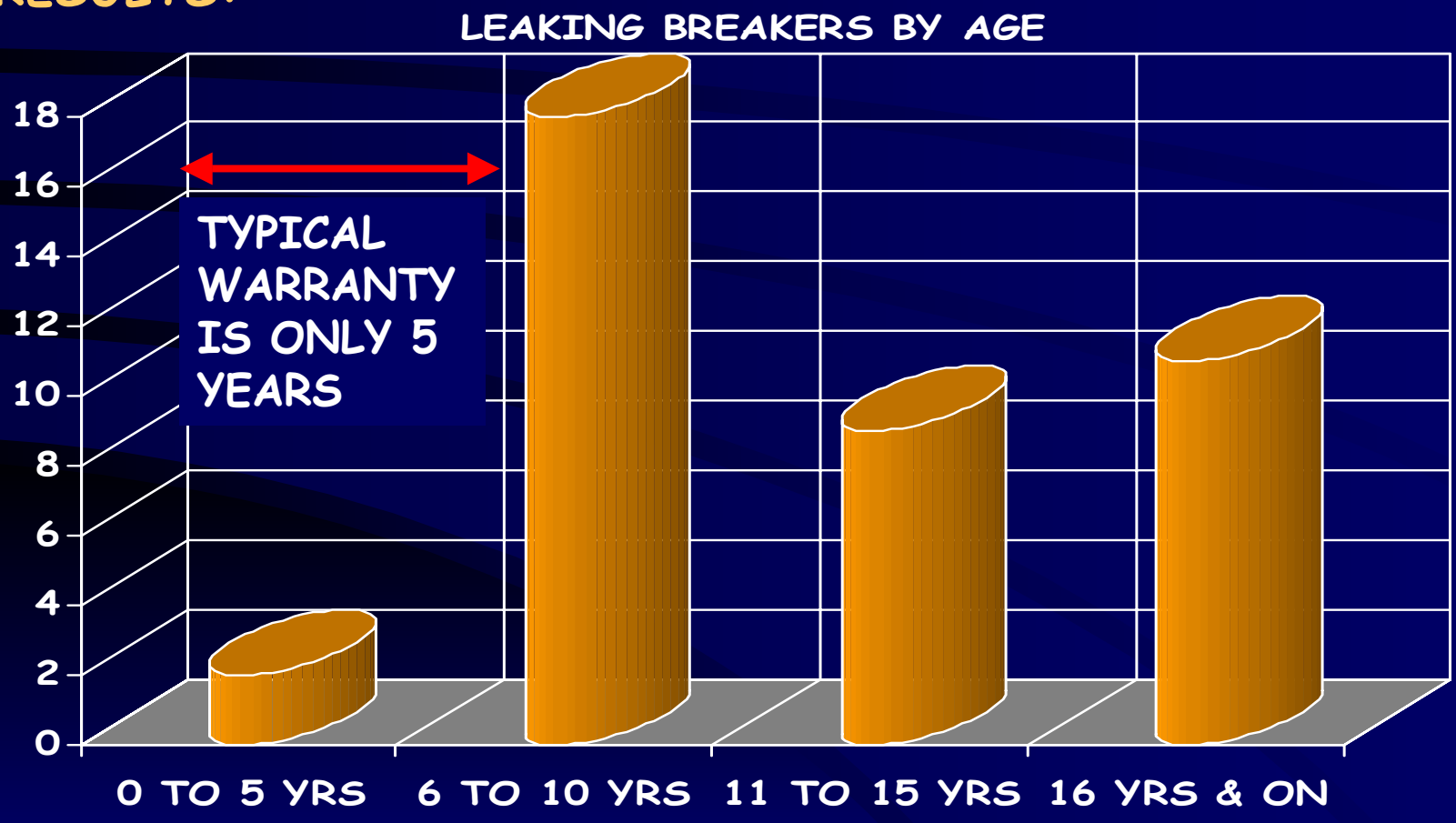

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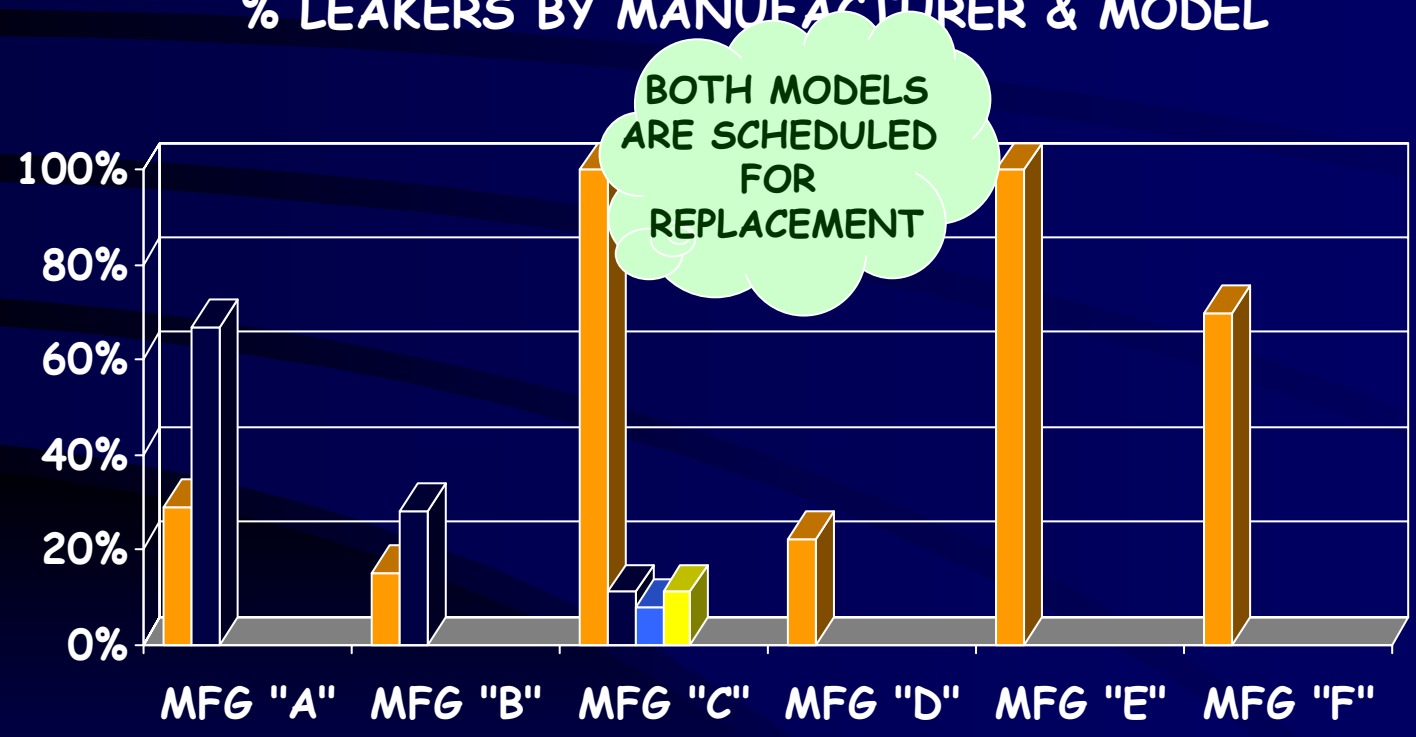

"SF_6 LEAK DETECTION"

RESULTS:

WHERE WERE THE LEAKS FOUND??

- 62% WERE FOUND AROUND FITTINGS, PIPING CONNECTIONS, & GAGE CONNECTIONS
- 16% WERE FOUND AROUND ACCESS GASKETS
- 12% WERE FOUND ON BUSHING SEALS
- 5% WERE FOUND AROUND DRIVE RODS
- 5% WERE FOUND AT WELDS

"SF_6 LEAK DETECTION"

CONCLUSIONS:

- "OUTSOURCING" LEAK DETECTION HAS BEEN ADVANTAGEOUS IN COST AND SPEED OF PROJECT COMPLETION
- INFRARED LEAK DETECTION ALLOWS FOR IDENTIFICATION OF SF_6 LEAKS WHILE EQUIPMENT IS STILL IN-SERVICE
- INFRARED LEAK DETECTION CAN NOT TELL VOLUME OF LEAKING GAS, BUT IT CAN IDENTIFY WHERE THE LEAKS ARE & OFTEN IDENTIFIES LEAKS UNDETECTABLE WITH OTHER TECHNIQUES
- THE "PARTNERSHIP" HELPED TO FOCUS EFFORTS ON CREATING A STRUCTURE & PROCESSES THAT ASSURE LONG TERM CONTROL AND CONTINUED REDUCTION OF SF_6 LEAKS