BANKABLE PILOT PLANTS

Fully Integrated Simulations of Continuous Operating Conditions

WHEN YOU NEED TO BE SURE

SGS

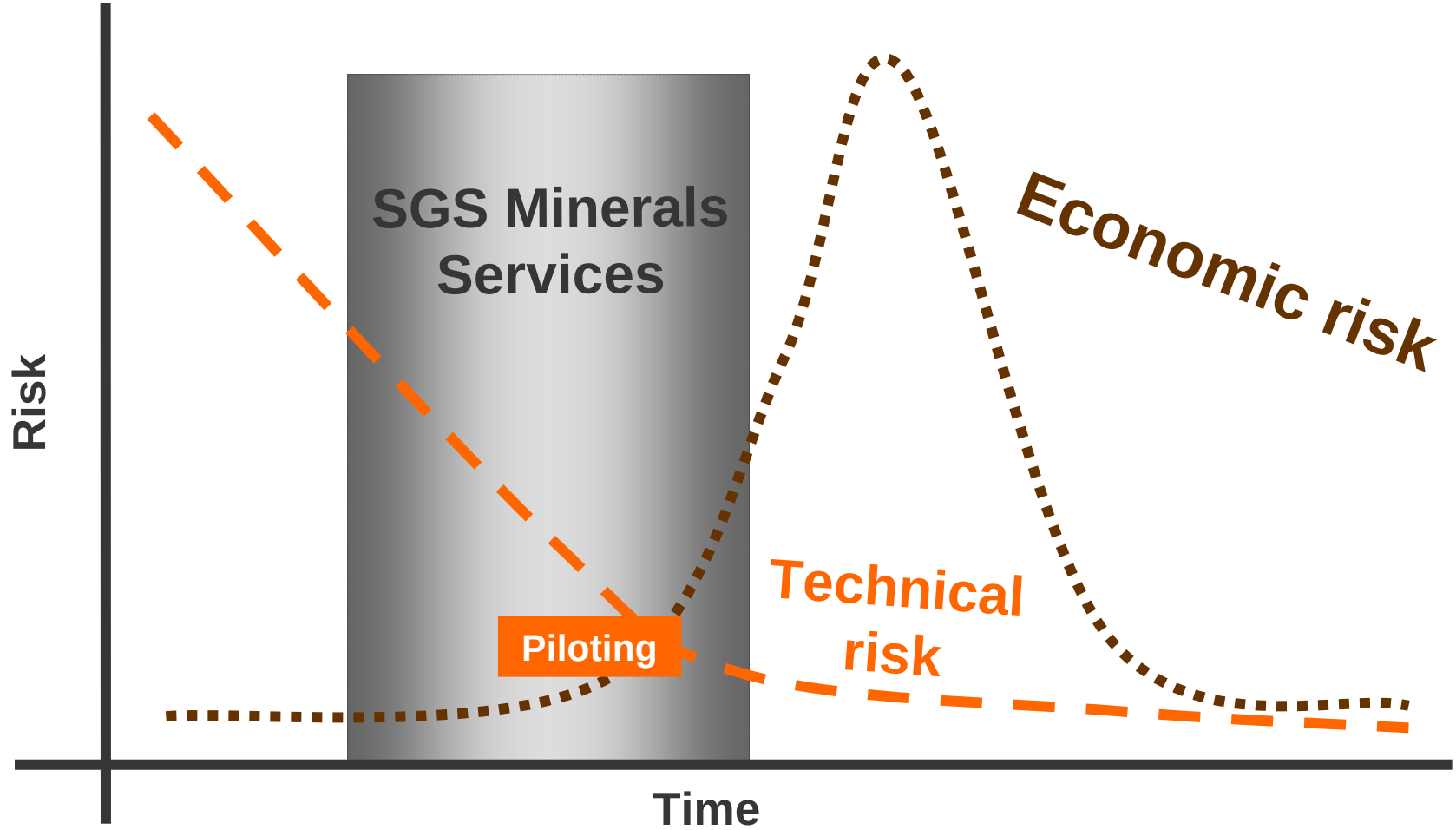
SGS ADVANCED MINERALOGY LABS

- Global leader
  - Certification & Verification
  - Inspection & Monitoring
  - Sampling & Testing
  - Risk management
  - Public company
  - Market cap $11.85B, no debt
  - 65,000 people
  - 650 labs in 7 industrial segments
  - 2000 offices

SGS MINERALS SERVICES

- Laboratory analysis
- On-site services
- Metallurgical testing
- Mechanical sampling systems
- Inspection
- Sampling

OUR ROLE IN MANAGING RISK



PILOT PLANTS

- Real-time integrated demonstration of processing circuit using expected feed, reagents and equipment.
- Pertinent for mining projects & industrial process design
- Pilot plants prove critical attributes of a commercial plant thus allow evaluation and troubleshooting
- Industry standard due diligence and risk reduction

INTEGRATED PILOT PLANTS

Beneficiation

PAL Circuit

Neutralization, CCD

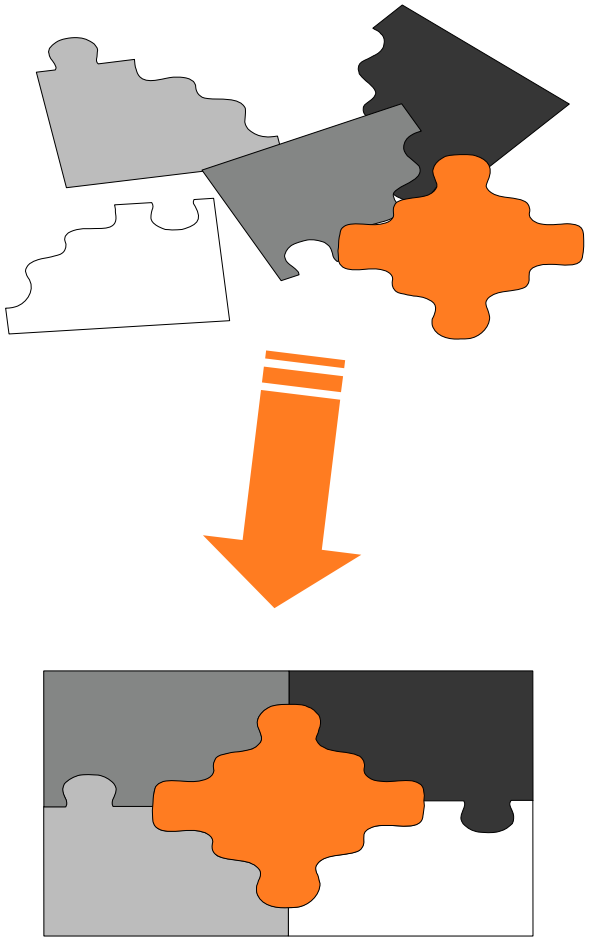
Precipitation, SX-EW

- 24/7 operation possible
- 150 dedicated staff, 70-80 hr weeks
- Metallurgy, mineralogy, analytical, process control, environmental
- On-site maintenance (electrical, mechanical, instrumentation)

VALUE OF INTEGRATED PILOT PLANTS

- Demonstrate anticipated operations
- Integrate unit processes in real time
- Review impact of feed variability
- Assess recycle streams
- Identify potential problems

  (operating, automation, corrosion, maintenance)
- Confirm energy needs, water balance and treatment, reagent consumption & equipment sizing
- Prove product quality and generate market samples
- Mitigate environmental concerns



DECADES OF EXPERIENCE

- 3-6 integrated pilot plants/year for 30 years
- 10 off-site, in-plant pilot plants
- 15 broad scope, in-plant services contracts
- 8 on-site start-ups

INTEGRATED PILOT PLANTS (SELECTED FROM 1998-2009)

- Boleo Cu, Au
- Skye Resources Ni
- MacKenzie Bay V
- Antamina Cu, Zn
- PolyMet/NorthMet many
- Key Lake (on-site) NiCo As
- Voiseys Bay Ni Cu
- Sepon, Oxiana Cu, Au, Ag
- Avalon Ventures REE
- North American Palladium PGE
- Farrallon Zn, Cu
- Nui Phao, Tiberon W, F, Bi
- Montcalm Ni, Cu
- Winnaarshoek, Impala PGE
- Pebble Au
- Oyu Tolgoi Au, Cu
- Pascua-Lama Au
- Pueblo Viejo Au
- Pogo Au

TYPICAL TIMELINE OF PROJECT DEVELOPMENT

- Characterize ore
  - Grade, mineralogy, beneficiation, settling, viscosity, geometallurgy
- Bench-scale testwork
  - Linked to process design criteria, variability testing, geometallurgy
- Process selection
  - Flowsheet development and optimization
- Pilot-scale testwork
  - Confirm design criteria on composites of various ore types
  - Create samples of final products for market evaluation.
  - Provide bankable assessment of operational viability

PILOT PLANT PREPARATION AND MANAGEMENT

Expertise	**Pilot plant management**	**Services**
Mineral Processing Hydrometallurgy Geometallurgy Environment Analytical Mineralogy Interdisciplinary	Project budgeting Pre-pilot testwork Flowsheet development Planning Design Construction Operation Data Collection Reporting Client relations	Maintenance Purchasing IT support Health, Safety and Environment Administrative support
Facilities Laboratories Pilot Plant Analytical Laboratory Advanced Mineralogy Laboratory		**Critical mass** Qualified workspace ~ 80+ staff 24/7 analytical coverage Dedicated trades

OPERATIONAL MANAGEMENT

Technical areas of expertise- Senior Metallurgists/ Project Managers/ Consultants

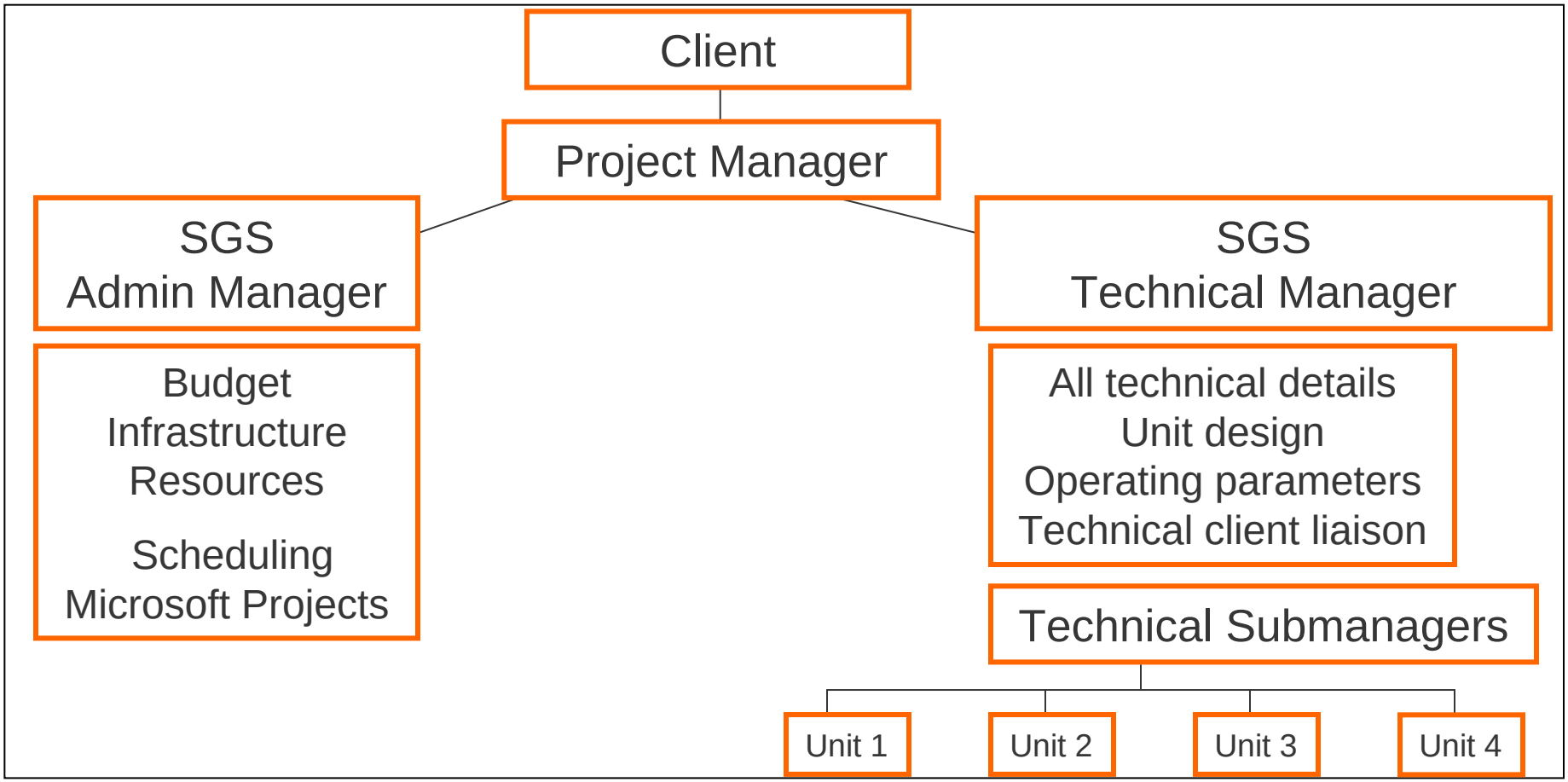
Administration Budgeting Resources Schedule	Leaching- POX autoclave Separations/ CCD/ Rheology SX-EW, Purification Overall technical and data management

Shift coverage 24/ 7 – circuits – Shift leaders/ technologists

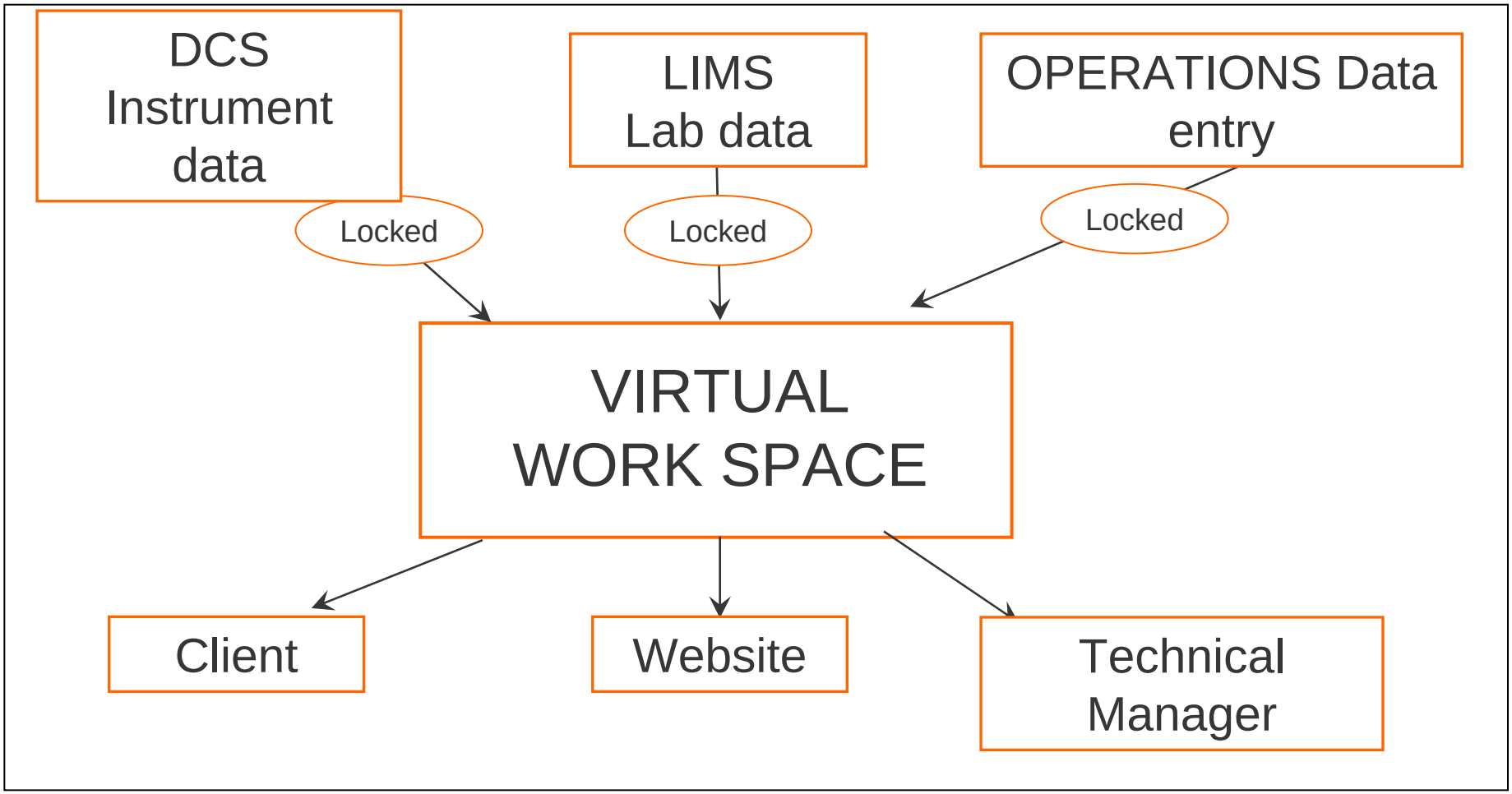
Front end – feed preparation and leaching
Neutralization – CCD
SX- EW
Iron removal
Precipitation circuits
Final treatment – process water make- up

Data acquisition 24/ 7 - Reporting – daily Client feed back

PROJECT MANAGEMENT OVERVIEW



DATA MANAGEMENT



LOGISTICS

- Typical sample size: 200 kg – 2 tonnes
- Minimum project time: 3 months
  - Planning: 2 weeks
  - Set-up: 1-2 weeks
  - Piloting: 3-5 weeks
  - Reporting 4-8 weeks
- Health and safety key considerations
- Ambient, heated, frozen sample storage options
- Sample ownership remains with you

INSTRUMENTATION

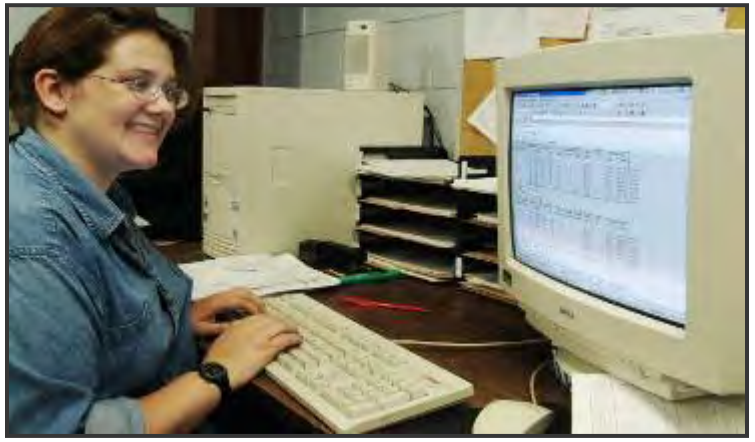
ON-LINE ANALYSIS

- XRF
- Particle Size Analysis

DIAGNOSTICS & CALIBRATION

LOGISTICS

- Quick connects
- Data entry
- Barcoded samples



TAILINGS MANAGEMENT

HEALTH AND SAFETY

- HazOp meetings

- PPE and Access Cards

ACCREDITED ANALYTICAL SERVICES

- Analytical
- Environmental
- Mineralogy

- Respected Quality – ISO 17025
- Numerous accredited labs in Canada, South Africa, South America, Australia, Russia, China

ADV. MINERALOGY SERVICE CENTRE

- Lab network providing automated process mineralogy services to high volume users.
  - QEM Scan (6 ys experience, 30+ projects)
  - XRD, SEM, electron microprobe
  - Image analysis
  - Petrography (PTS, PS), photography
- Applications
  - Ore-type definition
  - Plant control and optimization
  - Environmental and mine planning
  - Economic analysis

ADVANCED EXPERT SYSTEMS

- Expert system = knowledge base + reasoning engine
  Mimics human thought process
- Applications
  - Process control
  - Simulation and modeling
  - Scheduling and logistics
  - Advanced process control
  - Asset management
  - Data hosting and analysis

SITE SECURITY

- 24/7 security patrols
- Caging of products or site
- Final product can be secured

PLANT SECURITY

- Depends on client requirements
  - Secure access facility
  - Video surveillance of key areas
  - Tapes kept as required

DATA SECURITY AND IP

- Data Security and Access
- Intellectual Property

NEXT STEP: ON-SITE OPERATIONS

- Plant services
  - Commissioning
  - Management
  - Training
- Laboratory services
  - Design
  - Supply and outfitting
  - Operation
  - Training
  - Metallurgical accounting

PRE-PLANNED ALLOWANCES AND FLEXIBILITY

- Changes CONTROL the success of piloting game, must preplan. Allow for:
  - sample variability
  - key parameter adjustment
  - recycle streams flowrates
- Design, sizing and construction of equipment, piping and peripherals - adjusting residence times in ALL circuits
- Flexibility decreases with stage– from pre- to full-feasibility.

PLANNING

1	Transfer Metsim data/ test data
2	Determine pilot plant flow rates
3	Verify mass balance
4	Define: Residence time, Tank size and numbers, Surge volume, Cycle times
5	Produce detailed unit operations sequence
6	Select "off the shelf" equipment - tanks, pumps, sensors, peripherals..
7	Define control requirements
8	Selection of adequate flowrate measurement devices for gases and liquids
9	Design project -specific equipment - tanks, thickeners/ccd, "exotics", etc.
10	Define reagent requirements and order, include gas reagents
11	Produce Floor plan - request Client review if necessary
12	Final review before construction - include Client input
13	Construction
14	Attach instrumentation and control
15	Define detailed operating procedures
16	Define operating data logging requirements
17	Design sampling schedule, include sampling types
18	Design material management sheets
19	Define IT requirements
20	Produce first draft of pilot plants operations plans and submit to client for approval
21	General review - include Client input
22	Define Health and Safety requirements, including HAZOP
23	Engineers training session
24	Key personnel training session
25	All personnel training session and HAZOP

No one planned to fail. They failed to plan.

- **Written plan**
- **Checklist**
- **Update**
- **Manage**

FACTORS AFFECTING SUCCESS

- Sample
- Money, time, human resources
- Work scope vs. expectations and "moving targets"
- Severe “under-testing” at bench scale
- Key metallurgical expertise
- Technical advances

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